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THE TRAINING OF RESEARCH AND TECHNICAL PERSONNEL

SINCE the commencement of the year 1944, there have been notable utterances from the leading statesmen, industrial magnates, economists and scientific men regarding post-war reconstruction of our agriculture and industry. There is complete and wholehearted unanimity on the question of the utilisation of the immense natural resources of the country with the aid of tools offered by modern science and technology. In 1938, Lord Rutherford, in the course of his address to the Silver Jubilee Session of the Indian Science Congress, held at Calcutta, dealt at considerable length with the question of organisation of scientific research in India. He said, "This is in a sense a scientific age where there is an ever-increasing recognition throughout the world of the importance of science to national development. A number of great nations are now expending large sums in financing scientific and industrial research with a view to using their natural resources to the best advantage." The present war which has since intervened has brought into prominent relief the weaknesses in the agricultural and industrial economy of this country.

In the course of his Presidential Address to the Section of Engineering and Metallurgy Mr. Ghandy drew attention to the position of Indian industry as compared with those of the advanced countries. He said, "We are not able to manufacture aircraft or automobiles. A proper shipbuilding industry is still unknown. Our requirements of heavy machinery have to be supplied from abroad and we are content to utilise the great reservoir of scientific talent that exists in the country for the purpose of maintenance and operation of machines designed and constructed in foreign countries. What heightens the sense of tragedy is the fact that a country so unusually rich in natural resources as India should be so backward in industrial development."

Addressing the delegates of the Indian Science Congress held at Delhi, Prof. A. V. Hill spoke on the fundamental principles which guided the organisation and development of scientific and industrial research in England. In the course of this talk he referred to the four M's which are essential for the progress of science, men, money, material and machinery.

Of these, the last three could be mobilised; an enlightened and sympathetic government can enlist the enthusiastic co-operation of the public in finding the *money* and can arrange for the import of the necessary *machinery* to meet the urgent and immediate requirements of industrialisation. Nature has been exceptionally bountiful to us and can supply the raw *materials* needed for industry. The supply of *men*, however, offers difficulties.

The Government of India have constituted a Post-War Reconstruction Committee which has been entrusted with the task of planning the various nation-building activities during the post-war period. A few days ago, the leading industrialists of the country have published a memorandum outlining a Rs. 10,000 crores plan of economic development for India which is to be given effect to in three stages.

Professor Sir J. C. Ghosh, in the course of his Presidential Address to the Annual Session of the National Institute of Sciences, has pleaded for the immediate inauguration of a National

Research Council with the following functions: (*a*) to plan the main lines of scientific work in accordance with national needs, to formulate schemes for the above purpose, to review and modify the same whenever necessary and to recommend ways and means for implementing the results of accomplished researches; (*b*) to ensure balanced development of all branches of science and minimise overlapping; and (*c*) to advise and help relevant authorities regarding the training and supply of scientific personnel for pure and applied research.

The speed of scientific and technological progress will be limited by the supply of scientific and technical personnel. The training of highly competent and skilled personnel takes a long period. The selection and rise of the specially gifted among these workers will follow as a matter of course. Adolph von Bayer, the celebrated German chemist, who gave synthetic indigo to the world, once said that it took three years to train an infantry man, five years for a cavalry man, seven years for a gunner and nine years for a chemist. Dr. Bhabha, in a contribution to the symposium on post-war organisation of scientific research in India, writes, "Even if money is found for equipment, a highly trained and gifted staff cannot be created in less than a decade". Professor Sir Bhatnagar is of the opinion that the National Research Council, when founded, should take upon itself the responsibility of not only planning scientific work in accordance with national needs but also help in the training and supply of scientific personnel for pure and applied research. Sir J. C. Ghosh has invited attention to the way in which Russia faced the problem of supply of men. "In the planning of the development of scientific research, the Soviets began with the finding and training of men and then built the Institute later. They did not start with paper plans of Institutes in which men were subsequently made to fit." Emphasis should be laid upon the finding and training of researchers who would be called upon to tackle problems of industrial advance.

Even in England, it has been admitted that the number of trained personnel is inadequate to meet the growing demands of post-war reconstruction. "Admitting that the pre-war provision for research in Great Britain compares favourably with that of the U.S.A. or of Soviet Russia, it must not be supposed that the position can be rectified immediately by the allocation of financial and material resources more commensurate with the effort required. The supply of personnel alone, as Sir Stafford Cripps observed, is an obstacle to rapid expansion."

At the commencement of the first five-year plan which Soviet Russia launched soon after the last Great War, she was faced with a similar problem. It is instructive to recall how the question was tackled by her since India is faced with a closely analogous situation. Mr. Ghandy, in his Presidential Address referred to above, has outlined the scheme adopted by Soviet Russia in mobilising their technical personnel. The peoples' Commissariat of Education as the name signifies is in charge of education. It seems that a proper scientific bias is given to education. 'Pioneer palaces' or children's clubs, with their science laboratories and their exhibitions help the growth of a scientific outlook in the minds of young students, while science courses at the schools and the universities and the facilities for the conduct of research at the university laboratories in collaboration with the Science Research Institute of the Academy of Sciences, complete the scientific training of students and turn out a regular flow of scientific workers for the benefit on the community at large."

On the eve of Russia entering the present conflict "a decree signed by President Kalinin introduced a system for the replacement of schools under the control of individual factories and commissariats by the Government controlled schools organised on a national plan. It was not long before a network of industrial technical schools came into existence in Russia, Moscow alone having seventy such schools towards the end of the year 1942, each specialising in a particular branch of industry.

"Offering the attraction of a free education, free uniforms, and three free meals a day and guaranteeing decent employment at the end if a diploma is obtained, these schools have drawn hundreds and thousands of youths, including girls, in their middle teens, and have already provided tens of thousands of qualified workers for war industries." Here is an illustrious example of how the talent of a whole people could be harnessed by a national government for the promotion of its industry.

Two classes of workers are needed for reconstruction, the research worker and the technician. It is generally agreed that the universities should take the responsibility of producing the researcher while trade schools and polytechnic institutes should turn out the technicians. At the moment, the universities in India are not adequately staffed and equipped, to take up the additional responsibility of producing a larger number of scientific workers; admissions to the science and technical courses are restricted due to limited accommodation and poor facilities that exist. The trade schools and polytechnic institutes are few and far between considering the size of the country and the magnitude of the work that lies ahead. Given the necessary funds there should be little difficulty in expanding the teaching and research activities of the universities and increase the flow of trained research personnel. Large sums of money should be expended for the promotion of technical schools and for the establishment of a chain of polytechnic institutes throughout the country. These schools and institutes will provide the technicians needed for the advancement of industries during the post-war period.

We must take stock of our present scientific and technical personnel. A national register enrolling all the personnel available in the country may immediately be opened either by the Department of Education or by the Department of Labour. When the war terminates an appreciable number of scientific workers and technicians will be released and the question of their absorption by science and industry

should be carefully planned. These questions are best considered by a special committee which may be set up by the Central Government. Large capital grants both for university and technical education and research should be allotted; Sir J. C. Ghosh has suggested that a sum of Rs. 2·5 crores per annum should be expended for this purpose. The conditions of service should be rendered sufficiently attractive to induce the best of our young men to adopt a career of research or technology. The Government should consider the inauguration of a State Scientific Service on a parallel with the administrative Civil Service. It is earnestly to be hoped that the Government of India will give its immediate attention to this fundamental question of organising a steady supply of scientific and technical personnel for post-war reconstruction.

BEQUEST OF PAVLOV TO THE ACADEMIC YOUTH OF HIS COUNTRY

WHAT can I wish to the youth of my country who devote themselves to science?

Firstly, gradualness. About this most important condition of fruitful scientific work I never can speak without emotion. Gradualness, gradualness and gradualness. From the very beginning of your work, school yourself to severe gradualness in the accumulation of knowledge.

Learn the ABC of science before you try to ascend to its summit. Never begin the subsequent without mastering the preceding. Never attempt to screen an insufficiency of knowledge even by the most audacious surmise and hypothesis. Howsoever this soap-bubble will rejoice your eyes by its play it inevitably will burst and you will have nothing except shame.

School yourselves to demureness and patience. Learn to inure yourselves to drudgery in science. Learn, compare, collect the facts!

Perfect as is the wing of a bird, it never could raise the bird up without resting on air. Facts are the air of a scientist. Without them you never can fly. Without them your "theories" are vain efforts.

But learning, experimenting, observing, try not to stay on the surface of the facts. Do not become the archivists of facts. Try to penetrate to the secret of their occurrence, persistently search for the laws which govern them.

Secondly, modesty. Never think that you already know all. Howevér highly you are appraised always have the courage to say of yourself—I am ignorant.

Do not allow haughtiness to take you in possession. Due to that you will be obstinate where it is necessary to agree, you will refuse useful advice and friendly help, you will lose the standard of objectiveness.

Thirdly, passion. Remember that science demands from a man all his life. If you had two lives that would be not enough for you. Be passionate in your work and your searchings.

H. E. LORD WAVELL ON INDIAN SCIENCE

INAUGURATING the Thirty-first Session of the Indian Science Congress, His Excellency Lord Wavell said:—

"India, one of the oldest civilisations, has perhaps felt the impact of modern science later and less than any other great people. A large proportion of her population still lives the old life untouched by the vast changes of the century. Her realm has been of the spirit rather than of the earth. It may be said of the West hereafter that we took too much from India materially and too little spiritually.

> But if India is to play the part in the world to which her size, her population, her history and her position entitle her, she too must make every possible use of scientific advancement.

She has already produced many great scientists, she bears many more in her fertile womb. Her contributions to science have always been on the side of peace and progress. She has everything to gain by combining modern science with her old culture indeed her traditional outlook should enable her to make an increasingly fine and characteristic contribution to natural knowledge. Indian science has made in fact a very remarkable stride forward during the last twenty-five years, as is shown by the foundation of many new societies, new journals and new departments of science in universities and under Government.

In this war science has played a great role in India as elsewhere. It has made a splendid contribution to maintaining the health of the fighting men, through the activities of such bodies as the Malaria Institute, the Indian Research Fund Association, the Nutrition Laboratories at Coonoor, and others. It has also played an important part in munitions production and in solving problems of supply. As an ex-Commander-in-Chief, I should like to thank Indian science for the invaluable assistance it has given to the armies in the field.

> It must play a great part also in post-war development. The coming years will be vital to India. She must learn to make use of her abundant resources with the aid of science. Science is the most international of all human interests.

Professor Hill has himself said in an address elsewhere: 'I believe that the pursuit of knowledge for the welfare of mankind is one of the greatest agents for goodwill between men in every land.' It is in that belief that he is here to-day.

> This Session of the Indian Science Congress has a momentous task to perform; to discover how best to bring the aid of science to the development of India's great resources in agriculture and industry, to the improvement of health and to social advancement and prosperity."

COCONUT SHELLS AS AN INDUSTRIAL RAW MATERIAL

II. MISCELLANEOUS USES: FUEL

By Dr. REGINALD CHILD

(Director, Coconut Research Scheme, Ceylon)

THE first article[17] of this series reviewed in some detail the present state of knowledge of the chemical composition of coconut shells. This, the second, article aims at describing uses which have been made of shells in the past and are being made at the present time.

Utilization of Shells as Such

The uses which will be dealt with under this head can scarcely be described as industrial, but rather as domestic and ornamental.

Coconut shells have always been used in the domestic economy of coconut-growing countries in a variety of ways. To go no further back than the seventeenth century, Robert Knox[18] relates how that "..... when they (i.e., the Sinhalese) meane to make a bottle of the nutt they make but a little hole in one end & keepe it tell all the meate in the inside is rotted out & then it is like a bottle without a necke, in which they keep Racke* or oyle or any other liquor: some will hold a quart. The cups or dishes is onely to split the nut in the Middle as it will doe easear than any other way & then thare is 2 Cups made of one nutt."

Old Knox overlooked the fact that the half carrying the eyes is apt to "spring a leake" when the soft eye decays and that after all only one practicable cup is obtained from one "nutt". However, half-shells continue to be used in Ceylon as drinking cups in toddy taverns, as receptacles for collecting rubber latex, fitted with handles as scoops and ladles, and as begging bowls.

Bennett (1843)[19] gives a similar account and mentions containers for oil lamps and "sportmen's liquor flasks"! He also refers to the employment in Ceylon of a coconut shell as a resonant backing for a musical instrument. "The Singhalese *Vinah* is formed of a neatly carved or polished coconut shell (of which about a third part is cut off) and covered with guana skin (*Lacerta iguana* L.); to this is fixed a solid handle of about an inch in diameter, which is generally lackered with various colors, and, on the opposite side of the shell, a sort of peg is fixed, to which two strings, one of horse-hair, and the other of fine bow-string hemp (*Sensivierra zeylanica*), are attached; these strings are passed over a wooden bridge, upon the centre of the covering, one horizontally, and the other upon an inclined plane, the slope commencing from within three inches of the extremity of the handle, where it is perforated large enough to receive a strong peg of nearly half its circumference, and of about a fourth part of its length, having at the point a notch for the reception of the strings, which, by turning the peg, are kept in a state of tension, like the strings of a violin.—This instrument is played upon with a bow. ....."

* i.e., arrack.

Watt (1889),[30] says that "by Hindus, the dried shell is almost universally used as the water-bowl of their smoking-pipes or *hukah*. In Madras these shells are made into elegantly carved ornamental vases, lamps, spoons, sugar-pots, tea-pots, etc." He also gives a list of 83 different articles prepared from the coconut palm exhibited at the Colonial and Indian Exhibition in the 1880's, which includes several shell articles.

Burkill (1935),[20] has some interesting particulars of coconut shell vessels used in Malaysia. "The measure of capacity known as a 'chalok' is what a coconut scoop will hold. A 'chupak' is the amount which half a coconut shell will hold." Similarly Grisard and Vanden-Berghe (1889),[21] note that in Siam "..... les noix de coco coupées en deux sont graduées et employées comme mesures de capasité dans le trafic des graines et des liquides." Burkill adds some curious information on Malaysian folk-lore: "..... in Java, ... the coconut shell is held to be the appropriate vessel for medicines. In Sarawak, medicinal preparations in connection with births must be given in a coconut shell. Among the Malays a coconut shell vessel is used in a rice-ceremony because evil spirits must be confronted with objects which they recognize (Skeat, *J. Roy. Asiatic Soc.*, Straits Branch, 1898, 31, 13). In the Nicobar Islands a baby until two months old must only be washed in water from the shell of a young coconut (Whitehead, *In the Nicobar Islands*, 1924, p. 121).

The manufacture of such articles as have been mentioned has of course been often more than merely utilitarian, as the reference above to Watt's *Dictionary* indicates. Coconut shell is hard, takes a high polish, can be carved, if with some difficulty, decorated with lacquer, inlaid with silver or other metals, and generally used with ornamental effect. Local craftsmanship has, therefore, produced articles of frequently very attractive appearance, and characteristic of the native art of the various countries of origin.

Several early writers, including Regnaud (1856)[22] and Grisard and Vanden-Berghe[21] have noted that by washing with an alkaline solution and/or rubbing up with oil, coconut shell takes on a fine dark-brown to black shade, which enhances the attractiveness of articles made therefrom. "Gratée et polie", says Regnaud, "puis frottée d'huile ou lavée dans une solution alcaline, la noix de coco devient d'un beau noir, et se transforme, entre les mains d'un ouvrier industrieux, en toutes sortes d'ustensiles de ménage ou de simple fantaisie."

Of decorative work illustrations have been published of very ornate Indian work (lamps, goblets, flower-vases, etc.) by J. Shortt (1888),[23] of combs, ladles, bowls and stands, and water-dippers from East Africa by Hamel

Smith and Pape (1914),[24] and of more modern Ceylon ware by Pieris (1936).[25] Three good illustrations in Pieris' little volume show bangles, buttons, cuff-links, ash-trays, trinket-dishes and paper-weights; and a complete tea-set, including pot, six cups and sugar-bowl. Some of these are perhaps to be described as articles "de simple fantaisie"; the tea-set for example, is probably more ornamental than useful. Buttons and similar things such as studs are, however, practicable; Little (1908)[26] had many years before noted the occasional manufacture of buttons in Malaya, and even said, "it is proposed to send the shell to Europe for button manufacture".

It would doubtless be possible by curious literary research to extend considerably the foregoing account of domestic and ornamental uses of coconut shells; but the main features have been covered and one further reference must suffice. O. F. Cook (1910),[27] in the course of his attempt to show by botanical and historical evidence that the coconut palm had its origin in South America (a conclusion not now usually accepted), has a good plate of a small carved coconut found in a grave in the Chiriqui district of Panama. This specimen is carved in a simple design and is very attractive.

Use of Coconut Shells as Fuel

Of the enormous quantities of shells produced annually in coconut-producing countries (estimates of which are given in a later section), the uses discussed in the previous section account of course for a negligible fraction. Undoubtedly the bulk of shells produced have been and are in most countries used as fuel; they do provide for many purposes an excellent fuel, although Regnaud's comment: "Il n'y a pas au monde un combustible supérieur a la coque du coco" may be taken as rhetorical rather than factual.

Especially in countries where a well-developed plantation industry exists, shells are largely used for firing copra-drying kilns. Burkill (*loc. cit.*), for example, says that "it is the destiny of 70 per cent. of the coconut shells in Malaya to be burned for drying copra".

In Ceylon on most estates copra is dried by direct heat from burning shells in kilns of simple but effective design. Good descriptions of the procedure are given by Cooke (1932),[28] and by Pieris (1940).[29] Cooke notes that in Ceylon nuts are usually allowed to wither in storage for about a month before curing. In consequence a cleaner separation of the husks results and the shells are obtained free from adhering pith and fibre. The shells are also frequently dried before use. In this way clean-burning almost smoke-free fires are given by these shells.

The percentage of total shells used in copra drying naturally varies with conditions and with the efficiency of the kiln and its operators. Cooke (*loc. cit.*, p. 49) states that under unfavourable conditions, as with a draughty kiln or in wet weather, shell consumption may be between 75 and 100 per cent., whilst under good conditions only 25-50 per cent. may be used. In the writer's experience, Ceylon kilns do not attain the latter order of efficiency and about 60 per cent. consumption is probably normal. Lower consumption than this is only obtained in very dry districts where the copra is partly sun-dried (*cf.* Pieris, *loc. cit.*).

On small-holdings, as in S. India and to a large extent in Ceylon, shells are for the most part used as domestic fuel. On estates, any surplus left over from copra curing may also be so used, but in Ceylon, for example, there is a not inconsiderable sale to laundries, bakeries,* lime kilns, brick-yards and others requiring fuel. Cooke notices such uses and states that at the time of his enquiries (1931) the price obtainable was between Re. 0·90 and Re. 1·50 per 1,000 shells, though as much as Rs. 4·00 was paid for larger well-shaped shells for rubber tapping (see previous section).

In subsequent years Ceylon developed a considerable export business in coconut shell charcoal and the price of shells became largely dependent on the export price of charcoal, frequently being as high as Rs. 5·00 per 1,000. (Shell charcoal forms the subject of the next article in this series.) At the time of writing the price of shells at estates is round Rs. 2·00 per 1,000 whole shells.

Working with average Ceylon coconuts roughly 6,000 to 7,000 whole shells go to a ton. (Actual data are given in the next article.) Thus at the 1931 prices quoted by Cooke the fuel cost per ton was between Rs. 5·40 and Rs. 10·50, and compared favourably with other fuel when long transport was not involved. Scientific data do not appear to have been recorded on the calorific value of shells; it is likely to be over 7,500 British Thermal Units per lb.

Shells are not favoured as a boiler fuel; there seems to be a rapid corrosive effect of the vapours on fire-bars, etc., due partly to the high temperature reached and to the acid nature of the combustion products when air-intake is insufficient. (See Article IV on Products of Dry Distillation.) There is also in Ceylon a slight prejudice against their use in the cooking of food, especially meat, which the "creosotic vapours" are alleged to render tough and indigestible.

Shell Ash

The chemical composition of shell ash has been dealt with in the previous article.[17] It seems, however, desirable to conclude the present section on the use of shells as fuel, with a few supplementary remarks on the ash. Burkill is clearly wrong in stating (*loc. cit.*, p. 160) that the ash has but little manurial value, in view of its high potash content. The point is that something like a million shells are required to give a ton of ash. Furthermore, there is some loss of potash by volatization if the temperature of combustion is very high. Georgi (1941)[5] discusses the manurial value of shell ash.

Burkill quotes some uses of shell ash in Malayan native medicine, with which this article may be closed: "The ashes of a coconut shell with pepper, garlic and vinegar, make

* At the time of writing (Nov. 1943), for example, one large bakery in Colombo uses some 15,000 shells (about 2 tons) a week.

a medicament drunk after confinement (Skeat, *Mal. Magic*, 1900, p. 346). The ashes, with vinegar only, may be rubbed on the body (Ridley, in *Journ. Straits Med. Assoc.*, 1897, 5, p. 138). In the *Medical Book of Malayan Medicine* (*Gardens Bull.*, S.S., 1930, 6), the ash of coconut shell is prescribed in applications for swellings, pain in the stomach, and rheumatism; it enters also into a gargle. In no case is its presence anything but empirical, and in the treatment of swellings, the use of the eye-end of the shell suggests magic."

It is indeed difficult to see what effect the acetates formed by dissolving the ash in vinegar can have other than as a mild diuretic due to salt action.

17. Child, R., "Coconut Shells as an Industrial Raw Material. I. Composition of Shells", *Current Science*, 1943, **12**, 292–94. See this article for references 1–16, which have occasionally been re-quoted in the subsequent articles. 18. Robert Knox, *An Historical Relation of Ceylon*, etc. (Quoted from the edition published in 1911 by MacLehose & Sons, Glasgow, p. 420). 19. Bennett, J. W., *Ceylon and Its Capabilities* (London), 1843, pp. 87 & 103. 20. Burkill, I. H., *A Dictionary of the Economic Products of the Malay Peninsula* (Crown Agents for the Colonies, London, 1935), Part I, p. 609. 21. Grisard, J., and Vanden-Berghe, M., *Les Palmiers Utiles* (Paris, 1889), p. 68. 22. Charles Regnaut, *Histoire Naturelle, Hygienique et Economique du Cocotier* (*Cocos nucifera*, Linn.), Paris, 1856, p. 125. This little-known work was presented by its author, a native of Mauritius, to the Faculty of Medicine of Paris as his Thesis for a Doctorate. It is an interesting little volume, full of curious information, which deserves to be better known. 23. Shortt, J., *A Monograph on the Coconut Palm or Cocos nucifera*, 1885, Madras Govt, Press, 1888, Plates Nos. 5 & 6. 24. Hamel Smith, H., and Pape, F. A. G., *Coconuts: The Consols of the East*, "Tropical Life," Publishing Dept., London, 1914 (2nd edition), p. 350. 25. Pieris, W. V. D., *On the Uses of the Coconut Palm, with an Illustrated Guide to Coconuts* (Coconut Resesrch Scheme, Ceylon, 1936), p. 7 and Plates 37–40. 26. Little, R., "A Further Use for the Coconut," *Agric. Bull. Straits and F.M.S.*, 1908, **7**, 258. 27. Cook, O. F., "History of the Coconut Palm in America," *Contribution from the U.S. National Herbarium*, 1910, **14**, Part 2, p. 288, Plate 53, Fig. 1. 28. Cooke, F. C., "Investigations on Coconuts and Coconut Products," *Bull. No. 8 (General Science), Dept. of Agric., S.S. & F.M.S.*, 1932, pp. 22–33. 29. Pieris, W. V. D., *Methods of Copra Curing*, Illustrated leaflet, p. 8, issued by the Ceylon Coconut Board, Colombo, 1940. 30. Watt, G., *Dictionary of the Economic Products of India* (Govt. Press, Calcutta, 1889), **2**, 455, *et seq.*

RECENT WORK ON WOOD PRESERVATION AND IMPROVEMENT AT THE FOREST RESEARCH INSTITUTE, DEHRA DUN*

THE importance of protecting wood against destruction by fungi, termites, borers, marine organisms and fire needs no emphasis. The losses due to these agencies are enormous and the importance of wood preservation is obvious. In advanced countries wood preservation is synonymous with timber utilization and its economic importance is recognised. Further, but for the indirect influence of wood preservation on forest conservation, several million acres of forests would not be standing to-day in various parts of the world.

A proper understanding and practice of wood preservation demands a knowledge of several branches of science, *viz.*, chemical engineering, applied physics, chemistry, timber technology and a knowledge of wood destroying fungi, borers, termites and marine organisms, etc.

The foundations of wood preservation research in this country were laid by Sir Ralph Pearson of the Indian Forest Service about thirty years ago. With very limited equipment at his disposal, he carried out experiments on the treatment of railway sleepers and on various types of preservatives.[1] As a result of this work the first commercial treating plant was started by the N.W. Railway. This good work was continued by later officers and among work carried out by them may be mentioned the examination of the treatment characteristics of various species of Indian timbers,[2] natural durability tests, accelerated service tests,[3] service tests on treated sleepers,[4] the development of a new specification for the treatment of coniferous sleepers,[5] which enabled the Forest Department to obtain 50 per cent. more sleepers from the same volume of timber as were obtained before, and the evolution of the preservative Ascu[6] which aroused considerable interest.

The Forest Research Institute is equipped with four pressure cylinders wherein timber, varying in length from 3 to 40 feet, can be treated by all the standard pressure processes, five open tank plants, and a laboratory where all chemical, physical and chemical engineering work connected with the experiments can be carried out.

Toxicity Tests

In co-operation with the Mycologist, experiments are in progress to find out the most suitable fungi for use in toxicity tests. The reaction of Indian fungi to the more important preservative chemicals is being investigated. Toxicity tests on a commercial sample of cashew shell oil showed that, contrary to popular belief, the oil is not sufficiently toxic to wood-destroying fungi.[7] The toxicity of various types of Indian creosotes[8] and ascu[9] to wood-destroying fungi has been studied. Tests on the natural durability of various timbers and accelerated service tests on several preservatives have been carried out in the Institute's test yards.[10]

Preservatives

An important and extended investigation, recently undertaken, deals with the most suitable quality of creosote for use in this country. Several types of creosotes, and creosote fractions, have been and are being subjected to

* Contributed at the request of the Editor, *Current Science*.

extensive studies to evaluate the toxicity, permanence and penetrating power; normal and accelerated service tests are also being carried out.[11] The variation in the quality and quantity of creosote on exposure to atmosphere of treated timber, as also when subjected to oxidation have been investigated with interesting results.[12]

Post mortem examination of several failed ascu-treated poles[13] and treated sleepers from railway lines[14] in different parts of the country after various periods of service, have been carried out with the object of ascertaining the quantity and quality of the preservative still left in them. Some special leaching tests were carried out on ascu-treated timber.[15]

In view of the extreme shortage of preservatives of any kind in the country and the urgent demand for indigenous substitutes for war purposes, oil-soluble preservatives from the copper and zinc derivatives of chir pine resin and cracked vegetable oils have been evolved and tests on them initiated.[16]

Treating Processes and Plant Design

The work on the optimum treating conditions for the more important Indian timbers has been continued. Experiments on the treatment of several species of timbers in pole form indicated that the open tank process gives more uniform penetration than the Lowry process with some species. The difficulties experienced in Assam and on the West Coast in the seasoning of sleepers without decay, prompted an investigation on the conditioning and treatment of several species of sleepers in the green condition.[17] As a result of this work, a steaming and vacuum *cum* Boulton process of conditioning green sleepers has been developed with satisfactory results.[17a]

The treatment of green bamboo army tent poles by various processes has been studied.[18] To meet the demands of the army and other departments several simple designs of open tank plants with simple methods of heating have been developed.[19]

Resistance of Wood to Chafcoal

Work on the resistance of wood to corrosion[20] has been continued. Various types of linings for plywood containers have been tested and suitable coatings evolved for a variety of purposes including the storage of petrol.[21]

Resistance to Fire

Among other lines of investigation receiving special attention, may be mentioned studies on the resistance to fire of Indian timbers, both in the natural and treated states. The natural resistance to fire of 52 species of Indian timbers has been investigated.[22] Suitable apparatus was evolved for this purpose and the laws governing the burning of wood elucidated.

A fire-retardant composition, utilizing mica waste, has been evolved and the effectiveness of various compositions studied.[23] The influence of the cross-section of the member on the efficiency of fire-retardant treatments has also been studied.[23]

Thermal Properties

The thermal conductivity of over sixty species of Indian timbers in the air-dry condition has been examined.[24] Recently the specific heat of wood has also been investigated.[25] Preliminary experiments indicate that contrary to other work, probably some variation exists between species with regard to this property.

Electrical Resistance

In continuation of earlier work,[26] work on sleepers, poles and plywood has been taken up.

Permeability

In view of the importance of the knowledge of the factors affecting the permeability of wood with regard to wood preservation, etc., studies on the permeability of wood and other materials have been undertaken with interesting results.[27] This necessitated the design of a suitable clamp to avoid the necessity of end-sealing specimens, and other apparatus.

Sound Absorption

The sound absorption coefficients of various types of fibre and bark boards made at the Forest Research Institute and vibrating systems have been investigated.[28]

Improved Wood

Investigations on the production of "improved wood" by impregnation with synthetic resins have been carried out with interesting results.[29] Experiments on compressed wood also yielded interesting data.[29] Both laminated[30] and compregnated[31] wood have been produced from various Indian timbers and their properties studied. The influence of species, veneer thickness, adhesive used, the direction of laying of the veneers, and the conditions of pressing on the properties of the resulting product have been investigated. Compregnated wood, even from such an inferior timber as *semul*, has been found to compare favourably with foreign samples. Various parties are interested in the use of the material for ships tail shaft bearings, gear wheels, air-screw blades, shuttles. etc.

Adhesives

A scheme of research on various forms of plywood adhesives was initiated in April 1941. A systematic investigation of caseins of Indian origin was undertaken, and various formulæ for casein glues tested.[32] In view of the acute shortage of casein, other sources of proteins from indigenous materials for adhesives have been explored with encouraging results. Suitable adhesives have been developed from the proteins of oil seed cakes, seed proteins, etc.[33] Highly water-resistant adhesives have also been developed from the aq. alcoholic extracts of cereal meals.[34] Urea-formaldehyde resins, stable in syrup form for a few months and comparing favourably with foreign adhesives, were developed in response to requests from various departments.[35] Tar acid-formaldehyde resin adhesives were also developed from Indian tar acids with good results.[36]

Cork-Substitutes, Boards, etc.

In view of the acute shortage of cork, bottle stoppers were made from softened *Cryptomeria japonica*, which have been found suitable.[37] Various types of composition corks have also been developed from tree barks. Composition boards have also been made from sawdust and wood shavings using various types of binders.[38]

D. N.

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OBITUARY

P. ZEEMAN (1865–1943)

PIETER ZEEMAN, the famous Dutch Physicist, whose death has just been announced, was born at Zonnemain, Zeeland, in 1865. From 1885 to 1893 he studied at Leyden. In 1890 he became connected with the University as a privat-dozent and remained there until 1900 when he was appointed Professor at Amsterdam and later on Director of the Physical Institute. He made the great discovery known after him at the young age of 31, won the Nobel prize at the age of 37 and died at the age of 78. He was a member of many learned societies including the Royal Society and recipient of many degrees, medals, awards and numerous honours, and author of several papers and books.

Faraday had many years earlier, long searched for a relation between magnetism and light and had as early as 1862 placed a sodium flame in a magnetic field, observed the light in a spectroscope but found no effect. Faraday failed because his spectroscope did not possess the necessary resolving power and he did not use strong enough magnetic field. In 1896, Zeeman repeated Faraday's experiment with very strong magnetic fields and a powerful concave grating spectroscope and showed the splitting up of the spectral lines. The electron had just been discovered by J. J. Thomson and Lorentz on the basis of his theory of electrons supplied the explanation of Zeeman's great discovery. The normal triplets of Zn and Cd lines both with regards to their separation and polarisation were in complete accord with Lorentz's theory of electrons oscillating in atoms. The complex Zeeman effect of D lines and of green and blue lines of Zn and Cd which were soon after discovered by Zeeman and others were explained by Preston and Voigt and the discovery of the anomalous effect in the case of D lines by Paschen and Back in 1912 was further support and elucidation of the original theory. Bohr's theory of spectral lines was used by Debye and Sommerfeld in giving a newer explanation and opening up fresh fields of investigation.

Lande's prediction of a multiplicity of stationary states and the hypothesis of orientation applied to multiplets and later on the hypothesis of the spinning electron and the introduction of the splitting factor and the most important work on the hyperfine structure and investigation of Bismuth lines by Goudsmit and Back in weak and strong magnetic fields, furnished the complete explanation of the Zeeman effect. If Zeeman effect had not been discovered the nature of spectral series would have remained problematic.

It is a remarkable fact that though nearly half a century has elapsed since the discovery of the original effect, Zeeman's work has kept pace with the latest developments of atomic physics. Originally explained in an elegant manner on the classical theory, its full importance and explanation have been furnished by quantum theory and its effect on the nuclear physics has been of great value.

Zeeman's experimental genius has achieved valuable results in other fields too and his work on gravitation and mass and inertia has been of great importance, especially in the theory of Relativity.

He and his students have contributed a great deal to the investigation of hyperfine structure of spectrum lines and Zeeman effect on these. This has resulted in the development of apparatus of the highest resolving power and the use of the highest experimental skill. Zeeman's influence spread far beyond his country and valuable contributions have come from all over the world.

The world of science has lost a great genial personality whose epoch-making discovery has inspired research of the highest type in experimental and theoretical physics for nearly half a century and has yielded results of the greatest value in understanding the nature of the spectrum lines and the structure of matter.

Lucknow,
December 23, 1943. WALI MOHAMMAD.

STUDIES ON THE PRESERVATION OF GLANDS
III. The Preservation of Thyroid Glands

BY
B. B. DEY, P. S. KRISHNAN AND M. GIRIRAJ
(Presidency College, Madras)

THE thyroid gland, where the method of choice for medication is oral administration of the desiccated whole gland, offers an example *par excellence* of the principle of Organotherapy. This mode of medication presupposes a certain degree of stability on the part of the active principles towards heat treatment at moderately high temperatures and extraction with lipoidal solvents—two fundamental processes involved in the desiccation of the gland. The investigations that we have carried out on the changes undergone by the gland during storage under various conditions, go to show that the active principles of the gland possess a remarkable stability, in direct contrast to the Adrenal and the Pituitary glands.

It is now an established fact that the total organic iodine content is a better index of the biological potency of thyroid extracts than the thyroxine iodine content. Any deterioration undergone by the stored gland might, in part at least, be indicated by a decrease in the organic iodine content and a corresponding increase in the inorganic iodine. Assay of the acid-insoluble iodine, i.e., the thyroxine fraction, would also be a valuable index, since it would indicate any decomposition undergone by thyroxine into acid-soluble physiologically inactive organic iodo-compounds. In the following table are represented values for total iodine, thyroxine iodine, inorganic iodine and organic iodine in desiccated specimens of thyroid glands which were stored under a variety of conditions, the various assays being carried out by methods described in the *British Pharmacopœa*. Assays were also carried on two specimens of whole gland extracts, one of which, a desiccated product, had been stored at room temperature since 1941 and the other, a dried-gland preparation, had been stored in the frigidaire since 1941, until it was removed in November 1943 for extraction of fat.

It will at once be apparent from the table that the figures for thyroxine iodine and organic iodine percentages are remarkably constant throughout, irrespective of whether the glands are chilled immediately in dry ice or transported to the laboratory in ordinary ice or whether they are stored at 0° C. for two days or frozen for one month. Even when the dried glands (both before and after removal of fat) are stored for two years, either at 0° or at 30°, the changes undergone by the extracts in chemical composition are, for all practical purposes, negligible.

	I	II	III	IV	V	VI	VII
		Thyroxine Iodine		*Inorganic Iodine*		*Organic Iodine* (by difference between I & IV average values	
	Total Iodine (% of desiccated gland)	(*a*) % of desiccated gland)	(*b*) % of total I_2 (average)	(*a*) % of desiccated gland	(*b*) % of *total Iodine* average	(*a*) % of desiccated gland	(*b*) % of total I_2
1. Cattle Glands brought to the laboratory chilled in 'dry ice' and desiccated immediately	0·997 0·994	0·397 0·397	39·86	0·0167 0·0161	1·67	0·980	98·33
2. Cattle Glands brought in ice and desiccated immediately.	0·917 0·922	0·374 0·374	40·65	0·0146 0·0149	1·60	0·935	98·40
3. Sheep glands treated as in 1.	0·691 0·689	0·286 0·285	41·46	0·0180 0·0190	2·68	0·674	97·32
4. Sheep glands treated as in 2.	0·623 0 630	0·254 0·268	41·62	0·0157 0·0157	2·50	0·611	97·50
5. Cattle glands stored at 0–50 for 2 days.	0·931 0·933	0·359 0·357	38·41	0·0245 0·0266	2·74	0·906	97·26
6. Glands (cattle) frozen for 1 week	0·954 0·968	0·353 0·355	36·84	0·0235 0·0210	2·71	0·939	97·29
7. Glands (cattle) frozen for 2 weeks.	0·953 0·958	0·364 0·378	38·81	0·0213 0·0202	2·17	0·935	97·83
8. Glands (cattle) frozen for one month.	0 888 0 885	0·352 0·359	40·14	0·0180 0·0190	2·07	0·868	97·93
9. Dried glands (cattle) stored at 0–5 for 2 years.	0·928 0·922	0·3 3 0·380	40·22	0·1226 0·0236	2·50	0·902	97·50
10. Desiccated glands (cattle) stored at 30°C. for 2 years.	0·123 0·939	0·357 0·385	39·86	0·0182 0·0203	1·80	0 912	98·20

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LETTERS TO THE EDITOR

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DISTRIBUTION OF FISHER'S g_1 FOR SAMPLES OF THREE FROM A CONTINUOUS RECTANGULAR DISTRIBUTION

An easy method to find out the distribution of Fisher's g_1 for samples of three from continuous populations appears possible from the following considerations.

Let x_1, x_2, x_3 be the sequence in which the three individuals are observed and let

$$\tau_i=\frac{x_i-\bar{x}}{s} \text{ where } \bar{x}=\tfrac{1}{3}\sum_{i=1}^{3} x_i$$

$$\text{and } s^2=\tfrac{1}{3}\sum_{i=1}^{3}(x_i-\bar{x})^2. \qquad (1)$$

It is easy to see that if the τ_i's are arranged in ascending order of absolute magnitude forming the sequence τ_1', τ_2', τ_3'

$$\text{then } 0 \leqslant |\tau_1'| \leqslant \frac{1}{\sqrt{2}}\,;\ \frac{1}{\sqrt{2}} \leqslant |\tau_2'| \leqslant \sqrt{\tfrac{3}{2}}\,;$$

$$\sqrt{\tfrac{3}{2}} \leqslant |\tau_3'| \leqslant \sqrt{\ }. \qquad (2)$$

Also since

$$\sum_{i=1}^{3}\tau_i'=0\,;\ \sum_{i=1}^{3}(\tau_i')^2=3$$

$$\text{and } \sum_{i=1}^{3}(\tau_i')^3=\sqrt{\tfrac{3}{2}}\,g_1 \qquad (3)$$

we find that

$$g_1=\sqrt{6}\,\tau_i'\,(\tau_i'^2-\tfrac{3}{4}) \qquad (4)$$

and the distribution of g_1 can be determined once the distribution of τ_i' is known.

From the principles outlined elsewhere,[13] the distribution of τ_i' follows from the distribution of τ_i.

Also

$$\tau_i=\frac{\sqrt{2}\,\theta}{\sqrt{3+\theta^2}} \qquad (5)$$

where

$$\theta=\frac{x_i-\bar{x}'}{s'} \qquad (6)$$

$\bar{x}'$ and s' are respectively the mean and the standard deviation of the two observations left after excluding x_i. Hence if the probability distribution of θ is determined that of g_1 will follow immediately. This method is applied below to get the distribution of g_1 for samples of three from a continuous rectangular distribution. The notation used above has been kept up all through this note.

Rectangular Distribution

Let

$$\left.\begin{aligned} p\,(x_i)&=1 \text{ for } 0 \leqslant x_i \leqslant 1\\ &=0 \text{ elsewhere}\end{aligned}\right\} \qquad (7)$$

So

$$\left.\begin{aligned} &p\,(x_i, \bar{x}', s')\ .\ 4\\ &\text{for } 0 \leqslant x_i \leqslant 1\\ &\quad 0 \leqslant s' \leqslant \tfrac{1}{2}\,;\ s' < \bar{x}' \leqslant 1-s'\end{aligned}\right\} \qquad (8)$$

Also

$$\left.\begin{aligned} &p\,(\theta, \bar{x}', s')\ \ 4\,s'\\ &\text{for } -1 \leqslant \theta \leqslant 1;\ 0 \leqslant s' \leqslant \tfrac{1}{2};\ s' \leqslant \bar{x}' \leqslant 1-s'\\ &\text{for } 1 \leqslant \theta \leqslant \infty;\ 0 \leqslant s' \leqslant \frac{1}{1+\theta};\\ &\qquad s' \leqslant \bar{x}' \leqslant 1-\theta s'\\ &\text{for } -\infty \leqslant \theta \leqslant -1;\ 0 \leqslant s' \leqslant \frac{1}{1-\theta};\\ &\qquad -\theta s' \leqslant \bar{x}' \leqslant 1-s'\end{aligned}\right\} \qquad (9)$$

$$\left.\begin{aligned} \therefore\ p\,(\theta)&=\tfrac{1}{2} \text{ for } -1 \leqslant \theta \leqslant 1\\ &=\tfrac{2}{3}\cdot\frac{1}{(1+\theta)^2} \text{ for } 1 \leqslant \theta \leqslant \infty\\ &=\tfrac{2}{3}\cdot\frac{1}{(1-\theta)^2} \text{ for } -\infty \leqslant \theta \leqslant -1\end{aligned}\right\} \qquad (10)$$

Since

$$g_1=\frac{\sqrt{3}\,\theta\,(\theta^2-9)}{(3+\theta^2)^{3/2}} \qquad (11)$$

it follows that

$$p\,(g_1)=\frac{(3+\theta^2)^{5/2}}{27\sqrt{12}\,(1-\theta^2)} \text{ for } -1 \leqslant \theta \leqslant 1 \qquad (12)$$

which is equivalent to the two forms

$$p\ (g_1)=\frac{2\ (3+\theta^2)^{5/2}}{27\ \sqrt{3}\ (1+|\theta|)^2\ (\theta^2-1)}$$

$$\text{for } -3\leqslant\theta\leqslant -1;\ 1\leqslant\theta\leqslant 3$$

$$\text{and} -\infty\leqslant\theta\leqslant -3;\ 3\leqslant\theta\leqslant\infty. \qquad (13)$$

Substituting

$$\theta=\sqrt{3}\tan\alpha \qquad (14)$$

it is seen that these forms reduce to

$$p\ (g_1)=\frac{1}{\sqrt{12}\ \sqrt{3-g_1^2}\cos^2\alpha}$$

$$\text{for } -\sqrt{3}\leqslant g_1\leqslant\sqrt{3} \qquad (15)$$

where α lies between $-\frac{\pi}{6}$ and $+\frac{\pi}{6}$ and satisfies the equation

$$\sin 3\alpha=-\frac{g_1}{\sqrt{3}} \qquad (16)$$

NORMAL DISTRIBUTION

William R. Thompson (1935) has shown that

$$p\ (\tau_i')=\frac{1}{\pi\sqrt{2-\tau_i'^2}}\ \text{for}\ -\sqrt{2}\leqslant\tau_i'\leqslant\sqrt{2} \qquad (17)$$

$$\therefore\ p\ (g_1)=\frac{1}{\pi\ \sqrt{3-g_1^2}}\ \text{for}\ -\sqrt{3}\leqslant g_1\leqslant\sqrt{3} \qquad (18)$$

a result established by Fisher (1930). Comparing the distributions of g_1 for the rectangular and normal distributions it is seen that

$$p\ (g_1)\ \text{rectangular} \gtrless p\ (g_1)\ \text{normal}$$

$$\text{according as } |g_1| \gtrless 1{\cdot}3887.$$

All-India Institute of Hygiene
and Public Health, Calcutta,
November 10, 1943. C. CHANDRA SEKAR.

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ON DEFINING THE *a*-PHONEME

FOLLOWING Professor E. W. Scripture,[1] the term 'phoneme' is applied here to 'one of a group of similar speech sounds'. It is certainly a matter of fundamental importance to be able to define precisely the positive qualities (let us call them V and C) which characterise the vowel and consonant phonemes. Linguistics has not yet been able to arrive at these. It is because of this failure that Professor E. W. Scripture clearly points out the absolute necessity for a further work in *vowel analysis*; also, it is on account of this failure alone that certain phonemes are taken to be diphthongs which in reality turn out to be only long vowels in which the change is considerable.[2] Our normal expectation is that V and C must be mutually exclusive, *i.e.*, no sound-profiles can have both V and C. It is clearly seen from the phenomenon of the occurrence of the phoneme traditionally known as the *Āytam* in certain speech-forms in Tamil,[3] that V and C are not *exhaustive* characters of speech-sound-profiles. It is not true that a sound-profile must be either V or C. The *Āytam* is both not—V and not—C.

In the speech-forms where the *Āytam* occurs, it is preceded by a vowel (*the necessary condition*) and followed by a consonant (*the sufficient condition*). That is, in the actual articulation of certain Tamil words in the stream of speech, consisting of an integral part with a vowel, followed by a consonant, the *Āytam* occurs. In each such word, the sound-profiles which occur successively may be taken as an infinite class, densely ordered, which has initially the vowel-character, then a transitional character, and finally the consonantal character. For, a vowel is made up of a series of adjacent vibration profiles[4] the analysis of which show that all the frequencies from zero to infinity are present to a greater or less degree. 'The profile is, therefore, not a sum of a few discrete free vibrations as ordinarily supposed but an integration of an infinite number of such vibrations differing infinitely little from one another.'[5] Any spoken language consists of a succession of speech-sounds more or less overlapped[6] and these sounds can be grouped on the principle of similarity. The view that the speech is made up of a series of independent elements is erroneous.[7] 'Not only must we say that every individual sound changes from beginning to end but we must assert that each one develops out of the preceding sound and into the following one. There are no well-defined limits between neighboring sounds—not only because the limits are vague, but also because there are no independent sounds to be limited.'[8]

In this connection attention must be drawn to Professor Scripture's analysis of 'to race' (in plate VIII facing page 40). 'As the [t]-closure is opened, the vibrations appear in line 102. Are these weak vibrations to be reckoned to the vowel vibrations that occupy the rest of the line? Or are they to be treated as a "glide" from [t] to the vowel?' These are legitimate questions. But Professor Scripture does not appear to answer them. On the contrary, he appears to be merely to follow an arbitrary procedure in placing the beginning of the vowel at the point where the vibrations reach half a millimeter amplitude. Similar is his treatment with regard to other sounds as well (page 44). He himself admits that nowhere in the whole sequence is there any sudden change, nowhere any possibility of assigning limits. 'We must conclude that there are no such limits and that the sound changes gradually throughout.'

In this connection, it is interesting also to note that according to A. Tanakadate[9] the record of any single syllable of the Japanese sound elements, *e.g.*, that represented by the

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Kana (*ku*) or (*ke*) presents three characteristic portions. The beginning corresponds to the consonant *k*, the end corresponds to the vowel *u*; and there is an intermediate portion between the two where the amplitude of the oscillations is reduced to an insignificant amount. This middle portion does not play any important part in the formation of sound quality, or the Japanese Phoneme. Cutting away this part or lengthening it artificially does not change the reproduced quality of the sound or sound value. The same holds when the consonant is followed by any other vowel.'

It must be also remarked here that a change-point is ordinarily conceived to be any point at which any organ changes from one type of function to another and an α-sound is also similarly conceived to be a segment between two successive change-points.[10] But an α-sound is quite different from the α-phoneme (the *Aytam*). The latter is a speech-sound of a group while the former is merely a sound. Failure to recognise this distinction will lead to much needless confusion. But it is clear that there are no ascertainable change-points. All the laboratory investigations lead to the conclusion that it is certain that there are no definite change-points. It is also clear that we are dealng with *macrophonic* speech here.[11]

If we know the defining characters V and C, then we could give a rigorous definition of the *Aytam* by means of Dedekind sections, namely, we have a Dedekind section in which the lower segment consists of V (i.e., vowel sound-profiles) and the upper segment of not—V; we have also a second Dedekind section in which the lower segment is composed of not—C (non-consonantal sound-profiles) and the upper segment of C. The interval between the two section-points is the *Aytam* (the α-phoneme).

The *distances* bween the vowel, the α-phoneme and the consonant in each of our ordered classes have to be measured, and on the basis of the three *physical assumptions* stated already (in my paper on the sub-class of α-phoneme[12]) which are:—

(1) In the *transitional*, the vowel and the consonant are always together; there is superimposition.
(2) During the *transitional* as a consequence of superimposition the *masking effect* will be of importance.
(3) If the *duration* of the consonant extends beyond the refractory period there is a chance for the *audibility* of the consonant, in case the preceding vowel has an *influence* on the following consonant; the properties of the α-phoneme have yet to be experimentally studied. It needs no over-emphasis here that as some kind of accent distribution is involved in the occurrence of our α-phoneme, the relation between quantity and stress,[13] should not be lost sight of in our investigations.

The foremost advantage got by defining the α-phoneme can be easily seen to be the *conception* of a new 'bound' class (rather, a sub-class) of 'phoneme',[14]

Althouh the definition of the α-phoneme has so far been restricted by me only to certain speech-forms in Tamil, still as we meet with phonetic features in another Dravidian dialect Gōṇḍī similar to those that characterise the production of the *Aytam* in Tamil, I need hardly say that the formulation of the 'cut' conception may open up an altogether new vista. In Icelandic, too, we meet with a phoneme under conditions similar to those under which the *Aytam* seems to have appeared in old Tamil. In Kashmiri dialects, too, there appears to be a similar phenomenon.

The phenomenon of the *Aytam* (the α-phoneme) is, therefore, a strong pointer to the possibility of defining vowel and consonant phonemes by certain (so far undiscovered) positive characters V and C.[15]

Phonetics Laboratory,
Deccan College Postgraduate
and Research Institute,
10, Connaught Road,
Poona 1, C. R. SANKARAN.
December 14, 1943.

1 *Nature*, 1935, **136**, 261 and 644. 2. Scripture, Prof. E. W., *Researches in Experimtntal Phonetics*. pp. 43–45. 3. Sankaran, C. R., *Bulletin of the Deccan College Postgraduate and Research Institute (BDCRI.)*, **2**, 348–49. 4. Scripture, Prof. E. W., *Nature*, 1932, **130**, 275. 5. Wood, Alexander, *Acoustics* **360**. See also Sankaran, C. R., *BDCRI.*, **4**, 124. 6. Scripture, Prof. E. W., *Nature*, 1935, **136**, 759. 7. —, *Ibid.*, 1935, **136**, 456. 8. —, *Researches in Experimental Phonetics*, pp. 42–43, 58–59; Andrade, M. J., *Language*, 1936, **12**, 2. 9. "A Study of Japanese Phonemes by means of Tone Films," *Proceedings of the Second International Congress of Phonetic Sciences*, 1936, **118**. 10. Hockett, C. F., *Language*, **18**, 5. 11. Scripture, Prof. E. W., *Nature*, 1933, **132**, 138. 12. Sankaran, C. R., *BDCRI.*, **4**, 55–56. 13. Heffner, R. M. S., *American Speech*, 1941, **16**, 204–7; Haugen, E., and Twaddell, W. F., *Language*, 1942, **18**, 230. 14. Sankaran, C. R., *BDCRI.*, **3**, 393. 15. I am indebted to Dr. R. Vaidyanathaswamy, Department of Mathematics, University of Madras, for the clarification of many ideas in the matter of application of Dedekind section idea in defining the α-phoneme.

RAMAN FREQUENCIES OF CALCITE

FOLLOWING the earlier work of Bhagavantam and Venkatarayudu,[1] one of us has recently given a satisfactory explanation for most of the prominent features of the Raman spectrum of sodium nitrate.[2] In this note, the case of calcite is dealt with on similar lines.

1065, 860, 680 and 1,407 cm.$^{-1}$ are assumed to be the normal frequencies of the CO_3-ion in solution and using the well-known equations for the frequencies of vibration in such a case, the following force-constants are evaluated:
$K = 5{\cdot}45 \times 10^5$, $K_1 = 1{\cdot}75 \times 10^5$, $K_2 = 0{\cdot}45 \times 10^5$;
$K_3 = 3{\cdot}33 \times 10^5$.
In the crystal, besides altering the value of K_1 to $1{\cdot}86 \times 10^5$ so as to take account of the surrounding structure, three additional constants representing effectively all the interionic and other forces of the crystal are postulated and their values are given below:
$K_4 = 0{\cdot}22 \times 10^5$, $K_5 = 0{\cdot}38 \times 10^5$ and $K_6 = 0{\cdot}16 \times 10^5$.

Taking the above values of the force-constants, the frequencies that are to be attributed to the $CaCO_3$ crystal can be evaluated as follows:

A_1, (Raman active, infra-red inactive)—1084.
A_2, (Inactive in both)—877, 213, 0.
B_1, (Infra-red active, Raman inactive)—890, 331, 106.
B_2, (Inactive in both)—1082, 297.
E_1, (Infra-red active, Raman inactive)—1487, 676, 403, 225, 139.
E_2, (Raman active, infra-red inactive)—1433, 703, 277, 141.

The significance of the various force constants and that of A_1, A_2, etc., is fully described in the paper already referred to and is not repeated here for want of space.

The results thus obtained are summarised and compared with the experimental observations in Table I:

TABLE I

Raman effect	Calc.: 141, 277, 703 1084, 1438. Obs.: 155, 282, 709, 1084, 1434.
Infra-red absorption	Calc.: 106, 139, 225, 331, 403, 676, 890, 1487. Obs.: 106, 106, 182, 357, 320, 706, 879, 1429–1492.

The agreement is good. The appearance of lattice lines in the Raman spectrum and of low frequencies in the infra-red absorption, the lack of exact coincidence between the Raman and infra-red frequencies in respect of the degenerate modes, a shift in the value of the total symmetric frequency from the ion to the crystal are amongst the features that are satisfactorily accounted for.

Dept. of Physics,
Andhra University, S. BHAGAVANTAM.
Guntur, B. SUNDARA RAMA RAO.
January 7, 1944.

1. *Proc. Ind. Acad. Sci.*, 1939. **9**, 224. 2. *Ibid.*, 1944 **19**, No. 1.

REFRACTION OF ULTRASONICS AND VELOCITIES IN COLOURED LIQUIDS AND IN SOLIDS

IN the Debye-Sears method of diffraction of light by ultrasonic waves, the intensity of lines on both sides of the central line is symmetrical only when the sound waves are exactly at right angles to the light beam. This phenomenon was used to measure the refraction of sound waves. The vibrating quartz was placed in a metal vessel having a plane mica window and containing a liquid, say xylol. The vessel containing the quartz was placed in a bigger plate-glass vessel containing a second liquid, say water. Through this vessel a monochromatic light-beam was sent for diffraction effect. Now by simple arrangements the quartz plate could be rotated through an angle without disturbing any of the vessels and[2] the assembly of the two vessels could be rotated as a whole through an angle without disturbing the quartz with respect to the vessels. This was done by fixing the whole arrangement for rotating the quartz on to one of the vessels.

To begin with, the plane of the quartz was set parallel to that of the mica window. In this position, the ultrasonics being incident normally upon the mica window would suffer no bending. The outer plate glass vessel was rotated till symmetry of intensity in the spectrum was obtained. The quartz was then rotated through an angle "i". "i" was then the angle of incidence. The outer vessel was again rotated till symmetry of intensity was obtained. Clearly the angle between the rotations of the other glass vessel was the angle of refraction. Two applications follow immediately, *viz.*, finding velocities in coloured liquids and in solids, transparent or opaque. The coloured liquid is of course to be put in the inner vessel. In case of the quartz cannot be set accurately parallel to the mica window, then more than two settings of the quartz can be used and corresponding refractions found. The method then becomes somewhat mathematically cumbersome. If the coloured liquid is electrically conducting, so that the quartz cannot be directly put in it then an innermost vessel can be put inside the inner vessel containing the coloured liquid. This innermost vessel has to be made of plate-glass and quartz put in it along with some non-conducting liquid, so that the plane of the quartz is always parallel to the side of the innermost vessel. This can be permanently set by cementing the quartz on to the inside of the vessel. The whole innermost vessel has now to be used in place of the quartz alone.

Solids.—A prism or wedge of the solid can be made having a small angle "i". The quartz can be cemented plane on one face of the prism containing the angle "i". In one way of using it, a permanent line can be drawn at the base of the plate glass-vessel (no inner vessel) and for convenience parallel to its breadth, and along the direction of the beam of the light. The prism is made to stand in the vessel, so that the quartz directly faces the side of the liquid exposed for diffraction, the side of the prism being directly on the line. The vessel is now rotated till symmetry of intensity is obtained. The prism is then turned over, the other face of the prism containing "i" being on the ruled line. The waves have now to pass the prism in order to come to the part of the liquid used for diffraction. "i" then becomes the angle of incidence. The vessel is again rotated to get symmetry of intensity. The angle between the two rotations is the angle of refraction.

Accuracy.—The accuracy by this new method depends upon the accurate measurement or setting of the following:—

(1) Position of the crystal when intensity is symmetrical.
(2) Plane of the crystal parallel to the plane of the mica window. Of course any other suitable substance can also be used in place of mica, say glass.
(3) Angles of incidence and refraction.

As regards (1), Parthasarathy (1936) found

that rotation of the crystal through six minutes, completely changed the intensity from symmetrical to unsymmetrical. It seems from his paper that still lesser angles can be detected. For 2, among others, a screw-arrangement can be made for moving the crystal right up to the separation window, making the crystal flush with the window by proper rotation and then taking the crystal back. As already mentioned this setting can be dispensed with at the cost of mathematical computation.

Lahore,
September 16, 1943. R. PARSHAD.

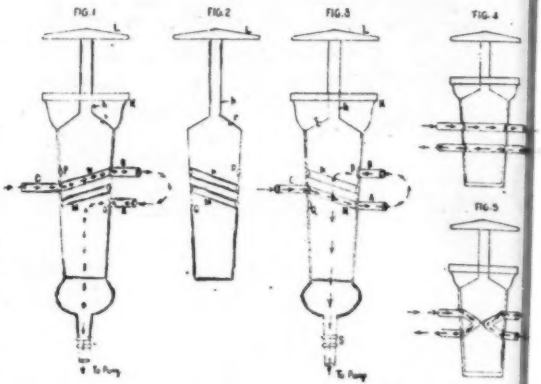
Parthasarathy, *Proc. Ind. Acad. Sci.* (A), 1936, **4**, 213. Bergmann's *Ultrasonics.*

A REVERSIBLE FOUR-WAY STOP-COCK USEFUL IN WORK CONNECTED WITH CIRCULATION OF GASES AND LIQUIDS

WHILE engaged in work connected with the measurement of the period of decay of active nitrogen the need for a four-way stop-cock capable of controlling the inlet and outlet of a chamber through which the gas is streaming was keenly felt. By suitable modifications in the existing three-way stop-cocks the author found that the above difficulty could be overcome, as also the stop-cock could be made a reversible one. As the new stop-cock proved of considerable use and as it would be of interest to workers in this and allied fields for circulation of gases and liquids, a short description of the stop-cock is given below along with a diagrammatic sketch of its working.

In Fig. 1 is shown an ordinary three-way mercury-sealed glass stop-cock. The plunger L is a hollow cylinder ground to fit the outer socket K. Two small glass tubes M and N are fused internally in L such that the side arm C of K could be connected with either A or B by proper manipulation of L. Normally S is closed with a pressure rubber tube fixed to a glass rod and mercury is poured into K when it fills up the hollow space in L through the hole r and covers the plunger a little above r. This so-called mercury-sealing gives further resistance to the entry of outside air into the stop-cock which the normal grease is unable to stop. Such a stop-cock can be easily converted into a four-way stop-cock. Bore a hole Q carefully through the wall of the plunger L so that when C makes connection with B, A is in communication with the hollow space in the plunger through the hole Q. The small hole r referred to above can be closed with sealing wax or any other cementing material. As an additional precaution mercury may now be poured above it to a small depth. S is extended by fusing an ordinary glass tube. Thus the stop-cock has now four arms, S, A, B and C. Supposing C is connected to the inlet of a gas reservoir and the chamber to A and B, and S to any suction pump. The gas now passes through from C into the chamber through N and leaves it through A and S, through the hole Q. The path of the streaming gas is shown in Fig. 1 by arrow marks. When the plunger L is now turned through 90° the inlet and outlet to the chamber are cut off and the gas is imprisoned in the chamber.

In order to reverse the direction of the flow of the gas in the chamber in position, i.e., without changing the relative positions of the reservoir connected to C and the suction pump connected to S, bore another hole through the wall of the plunger L at a place P such that when C is in connection with A through M,



P connects B with S through the plunger. This is shown in Fig. 3. Now the gas passes through the chamber in the reverse direction as shown by the arrow marks. When the stop-cock is now turned through 180° the direction of the flow of gas through the chamber is once again reversed (*cf.* Fig. 1). The plunger with the proper holes P and Q bored as described above is shown in Fig. 2.

Thus the new type of four-way reversible stop-cock can be made by modifying the existing three way stop-cock as described above. If, however, the reversibility referred to above is not essential then the simpler types of four-way stop-cocks diagrammatically shown in Figs. 4 and 5 may conveniently be employed. The use of such four-way stop-cocks in work connected with the adsorption of gases and vapours by solids, decomposition of gases under electric discharges in ozonisers and other similar discharge tubes, measurement of the period of decay of after-glows, in interferometric work with gases, etc., wherein circulation of gas is of considerable importance, cannot be overestimated.

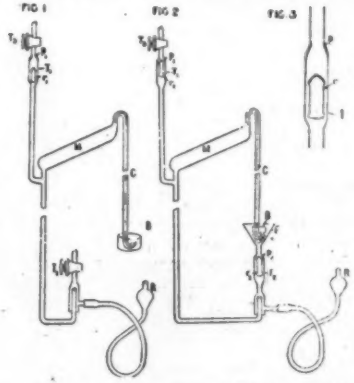
The author takes this opportunity to express his grateful thanks to Dr. S. S. Joshi, M.SC., D.SC. (Lond.), University Professor of Chemistry, of the Benares Hindu University, who gave him facilities to conduct the work.

Forest Research Institute,
Dehra Dun, A. PURUSHOTHAM.
September 10, 1943.

SOME IMPROVEMENTS TO THE TOPLER PUMP

THE two main difficulties generally experienced in the working of a Töpler pump (Fig. 1) are (1) the leakage of mercury through the stop-cock T_0 under the pressure of the mercury in the reservoir when the latter is raised to push out the gas from the main body M of the pump through the capillary C, in spite of all usual precautions being taken and, (2) the very careful attention to be paid by the worker in transferring again and again the excess of mercury, thrown out through the capillary C during the working of the pump, into the reservoir R. Neglect of the latter results in the overflowing of the mercury from the basin B. To avoid both the above-mentioned difficulties the modification devised by the author has been found satisfactory in use.

The modification adopted is simple and consists in putting in a ground-in trap T_0 (Fig. 2, similar to the one used in the inlet to the pump, *i.e.*, T_1) in place of the stop-cock T_0 (Fig. 1). This is shown in detail in Fig. 3.



To the end of this trap is fused an ordinary funnel F (Fig. 2) such that the basin B which receives the mercury flowing through the capillary C, seats itself comfortably over a base (say a pipe clay triangle) placed inside the funnel. This is shown in Fig. 2. The function of this trap T_0 like the Trap T_1, is to close the passage to the mercury when the reservoir is lifted up in the course of the evacuation of the gas contained in the body M of the pump. This is achieved by the pushing up of the ground-glass hollow cylinder r_0 gradually against the ground-in passage P_0 by the rising mercury in the trap T_0. The mercury now flows up the body M of the pump displacing the gas completely through the capillary C. When the reservoir is lowered the ground-glass cylinder r_0 recedes along with the mercury column thus enabling the excess of the mercury overflowing the basin B to go down automatically into the reservoir through the trap T_0. Thus the addition of the trap T_0 as described above not only eliminates the stop-cock T_0 (Fig. 1) along with the other difficulties consequent on its use (outlined above), but also obviates the necessity of transferring into the reservoir the mercury overflowing the basin, which need be done rather very often with the normal type of the pump.

The author wishes to place on record his grateful thanks to Dr. S. S. Joshi, M.SC., D.SC. (Lond.), University Professor of Chemistry, of the Benares Hindu University, who gave him facilities to conduct the work.

Forest Research Institute,
Dehra Dun, A. PURUSHOTHAM.
September 10, 1943.

CHROMOSOME NUMBER OF *CARICA DODECAPHYLLA* VELL FL. FLUM

THE chromosome number of *Carica pubescens* Lenne and Koch, a strictly dioecious species was reported in a previous note[1] to be $2n = 18$ and it was pointed out that the somatic complement showed no heteromorphic pair of chromosomes to distinguish the two sexes. During further investigations on the cytology of *Carica*[*] the chromosome number and their characteristics of *C. dodecaphylla* Vell. Fl. Flum which is also a strictly dioecious species have been determined. Cytological examination of about fifteen metaphase plates from about ten root-tips revealed the diploid number to be eighteen in this case also. No marked differences are discernible between the somatic compliments of *C. dodecaphylla*, and those of *C. pubescens* and *C. papaya*. Besides, the position of attachment constriction is the same, namely, median or sub-median in the above three species of *Carica*. Distinctly heteromorphic pair of chromosomes could not be noted. The absence of a heteromorphic pair of chromosomes in *C. pubescens* and *C. dodecaphylla* and the similarity of chromosomes of these and other investigated species of *carica* appear to further support the view expressed by Storey (1941) of close relationship among them.

Our thanks are due to His Majesty's Consul-General at Buenos Aires, for seeds of *C. dodecaphylla*.

College of Agriculture,
Poona, L. S. S. KUMAR,
December 23, 1943. V. K. SRINIVASAN.

[1] Kumar, L. S. S., and Abraham, A., *Curr. Sci.*, 1941, **11**, No. 2, 58. [2] Storey, W. B., *Hawaii Ag. Expt. Station Bull.*, 1941, No. 87, 6-7.

[*] Scheme for research on the "Cytology of *Papaya*," financed by the Imperial Council of Agricultural Research, New Delhi.

A NEW GENE FOR LINTLESSNESS IN ASIATIC COTTONS

THE appearance of lintless mutants in Asiatic cottons has often been reported and their genetic behaviour described by different workers in India. In 1940, the writer came across one such mutant in the Broach 9 (*G. herbaceum*) seed multiplication area at the Baroda Agricultural Experimental Station. The mutant is characterised by a hairy plant body and a

thickly fuzzy seed-coat. It is thus similar in appearance to another lintless mutant which was discovered in 1932 in miscellaneous herbaceum material at Broach and the seed of which was kindly supplied to the writer by Mr. G. B. Patel, Cotton Breeder, Viramgam. The Baroda mutant was crossed with this and other known lintless mutants, in order to study its genetic relationships. The results obtained so far are briefly given below.

Baroda lintless × Broach 9 linted: The F_1 was linted. A single F_2 family consisting of 125 plants gave 96 linted: 29 lintless. On a 3 : 1 basis, the fit is good (x^2=0·216, P=0·5–0·7) and represents a single-factor segregation.

Baroda lintless × Viramgam lintless: F_1 was lintless and resembled the parents. In a single F_2 family of 147 plants, all plants were lintless like the parents. The same gene is thus responsible for lintlessness in both these types.

Baroda lintless when crossed with 1027 A.L.F., 1027 A.L.F. × Wagad, Dharwar, Nagpur, Mollisoni, Punjab glabrous and Nandyal lintless types gave a linted F_1, showing that the Baroda gene is distinct from these other mutants and complementary to them. In its cross with the Punjab hairy lintless, Baroda lintless gave a lintless F_1; but that these two genes are different is seen from the fact that in common crosses with 1027 A.L.F., 1027 A.L.F. × Wagad and Nagpur lintless, the Punjab hairy lintless gave a lintless F_1 whereas the F_1 with Baroda lintless was linted as stated above.

It is clear from these results that Baroda and Viramgam lintless represent independent mutations at the same locus and that they are distinct from other lintless types and complementary to a majority of them. The factor pair corresponding to the new mutant and the normal may be designated as $Li_d - il_d$. Further work to study the linkage relations of the gene is in progress.

Economic Botanist,
Baroda, G. K. GOVANDE.
October 6, 1943.

REGENERATIVE CAPACITY IN *PERIONYX SANSIBARICUS* MICHAELSEN (1891)

THIS earthworm, which is rather widely distributed in India from Allahabad to South Malabar, has been known hitherto only from preserved museum material. Through the kindness of W. B. Hayes, who furnished the specimens, and of I. D. Caleb, who provided the opportunity and facilities for the work, it has now been possible to study live individuals.

The species appears to have an unusually high regenerative capacity for an earthworm and to indicate in a preliminary way that capacity is the purpose of this note.

Worm 1.—A posterior portion (substrate) developed at intersegmental furrow 81/82, in 3 weeks, a head of 16 segments which was then removed. After this operation the substrate autotomized the last 15 segments. The remainder of the original substrate, in the next 11 days, regenerated a second head, this time of 13 segments, and a small tail 1½ mm. long. After removal of both ends, a piece, now comprising only segments 88-122 of the original substrate, formed in 12 days at the anterior end a head of 14 segments, 3 mm. long, and at the posterior end a tail of 6 setigerous segments (and anal growth zone) 1 mm. long. The tail piece autotomized from the original substrate, survived but during the combined periods of development of the second and third heads, was able to produce at its anterior end only a single anal segment with no growth zone.

Worm 2.—A posterior substrate developed at 50/51 in 15 days a head of 17 segments. The new head and first four segments of the original substrate were then removed and the remainder divided into three pieces: (*a*) segments 55-113; (*b*) segments 114-143; (*c*) segments 144-163. In 15 days the (*a*) piece, now only 20 mm. long, produced a head 3 mm. long of 14 segments, and a tail 1½ mm. long, of 7 setigerous segments. The (*b*) piece, in 8 weeks, produced only a single anal segment at each end, while the (*c*) piece (5 weeks) formed only a single anal segment at the anterior end.

Worm 3.—A substrate comprising segments 21-50 autotomized the last 8 segments (which died) and then regenerated in 18 days a head 4½ mm. long of 16 segments, and a tail of 18 setigerous and pigmented segments. Head and tail regenerates with proximal 4 and 3 substrate segments were removed and discarded. In 26 days the remaining portion, now only 5 mm. long and of 13 segments, regenerated at each end a head, the anterior head 2½ mm. long with 13 segments, the posterior head 1½ mm. long and of 9 segments. The posterior portion of the original worm, segments 51-159, produced in 3 weeks at the anterior end, a head 6 mm. long of 19 segments.

Worm 4.—A substrate comprising segments 41-65 produced in 21 days a head of 4 mm. long of 17 segments, and a tail 7 mm. long. The substrate now comprised only 23 segments, 2 having been dedifferentiated and incorporated into the head and/or tail.

Worm 5.—This worm escaped and the next noon was found about 3 inches from its container, coiled up in full glare from a bright sky. The body was stiff but not brittle. The worm was placed in water. After a few moments the anterior half began to jerk back and forth but these movements soon ceased. The next day anterior and posterior portions were not only dead but decayed. There was no sign of autotomy. Dead parts were trimmed off. The remainder, of 22 segments, survived and regenerated a head of 13 segments as well as a tail 2½ mm. long.

Ewing College,
Allahabad, G. E. GATES.
November 12, 1943.

RESPIRATORY MOVEMENTS IN CARP FINGERLINGS

REDUCTION in oxygen in a medium invariably causes the fish to come to the surface and gasp for air. Their breathing on such occasions is always rapid. Whenever such a phenomenon has been observed, whether in a tank or in an aquarium, the test has always revealed either the presence of toxic substance or diminished

dissolved oxygen in the medium. Belding (1929)[1] pointed out that "the respiratory movements are an important aid in the diagnosis of fish disease and in differentiating the reaction of fish to a toxic environment". The respiratory movements of fish have not so far been utilized in this country for the differential diagnosis of fish ailments or toxic environments.

During the course of an experiment on the oxygen requirements of the carp fingerlings (Hamid Khan, 1940)[2] it was observed that the fry at the commencement of the experiment settled down at the bottom of the container with certain regularity in their respiratory movements as indicated by the opening and closing of their operculum, but as the oxygen became reduced, the fry came to the surface breathing rapidly and gasped for the air. Investigation of the rate of their respiratory movements gave some interesting results which are presented in this article.

METHOD

The carp fingerlings, namely, Rohu, *Labeo rohita* (Hamilton) and Mori, *Cirrhina mrigala* (Hamilton), measuring 5 to 6·5 inches from tip of the snout to the base of the caudal fin, were confined in air-tight containers with a capacity of 8·17 litres each. Two fry were put in each container, which was filled with fresh water to the top and stoppered to avoid air contamination. The respiratory movements of the operculum were observed with a stop-watch for one minute after interval of every twenty minutes till the fish showed signs of suffocation. The temperature of water in the experiment performed during October ranged from 72° F. to 75° F., while in the experiment

TABLE I

Respiratory movements of carp fingerlings, Cirrhina mrigala *(Hamilton) and* Labeo rohita *(Hamilton)*

Serial No.	Species of Fish	Interval in minutes after confinement											Remarks
		5	25	45	65	85	105	125	145	165	185	205	
	(i) Rate of respiration per minute when temperature ranged from 72° F to 75° F												
1	*Cirrhina mrigala*	70	70	75	85	121	143	159	134	..	..	..	Fish overturned, taken out
2	Do.	89	85	87	115	140	156	170	150	..	..	..	
3	Do.	65	75	75	82	88	94	124	148	..	..	..	Fish taken out
4	Do.	78	94	90	96	99	105	140	202	..	..	..	
5	Do.	74	74	76	81	103	93	98	102	142	183	114	Fish overturned, taken out
6	Do.	54	56	56	64	70	76	80	91	130	160	120	
7	Do.	72	72	78	94	134	165	164	94	..	..	..	Do. do.
8	Do.	80	82	93	118	152	186	173	62	..	..	..	
9	*Labeorohita*	85	91	95	98	99	113	123	148	..	..	..	Fish comfortable, taken out
10	Do.	121	131	142	150	160	165	170	175	..	..	..	
11	Do.	83	80	106	104	126	161	166	93	..	..	..	Fish overturned, taken out
12	Do.	76	78	103	114	132	178	174	93	..	..	..	
	(ii) Rate of respiration per minute when temperature ranged from 80° to 87°												
1	*Cirrhina mrigala*	161	167	200	242	258	212	165	..	..	..	..	Overturned, died
2	Do.	206	213	228	256	272	226	188	..	..	..	..	Do.
3	Do.	160	144	164	210	250	270	281	..	..	..	..	Fish taken out
4	Do.	145	120	150	160	220	250	270	..	..	..	..	Do.
5	Do.	140	167	180	215	225	190	..	..	..	..	..	Do.
6	Do.	118	124	135	148	150	168	185	..	..	..	..	Do.
7	Do.	116	142	158	177	197	188	190	..	..	..	..	Do.
8	Do.	175	170	166	180	190	190	132	..	..	..	..	Do.
9	Do.	152	150	158	182	184	198	138	..	..		..	Do.
10	Do.	112	130	148	147	165	190	175	168	..	..	..	Do.
11	Do.	147	136	198	206	214	..	..	..	..	..	..	Do.
12	Do.	146	150	194	202	180	..	..	..	..	..	..	Do.
13	Do.	152	172	206	208	202	..	..	..	..	..	..	Do.
14	Do.	132	150	160	172	184	190	206	195	..	..	..	Do.
15	Do.	132	130	196	224	230	185	..	..	..	..	..	Do.
16	Do.	108	122	170	198	232	..	..	..	..	..	..	Do.
17	Do.	120	146	180	200	220	214	..	..	..	..	..	Do.
18	*Labeorohita*	150	..	217	242	270	254	..	..	..	..	..	Do.
19	Do.	127	147	158	177	183	200	166	167	..	..	..	Do.
20	Do.	164	142	232	220	196	..	..	..	..	..	..	Do.
21	Do.	160	172	208	222	160	..	..	..	..	..	..	Do.
22	Do.	132	170	210	210	206	142	..	..	..	..	..	Do.
23	Do.	140	170	210	220	242	190	..	..	..	..	..	Do.
24	Do.	124	130	196	212	240	196	..	..	..	..	..	Do.

TABLE II
Gaseous contents, temperature and pH value of the medium

Serial No. of experiments as in Table I (*a*) from 1–12	Before the experiment						After the experiment						Remarks
	Gases c.c. per litre				Temperature	pH	Gases c.c. per litre				Temperature	pH	
	Carbon dioxide			Oxygen dissolved			Carbon dioxide			Oxygen dissolved			
	Free	Half bound	Fixed				Free	Half bound	Fixed				
1–2	1·769	23·257	23·257	5·23	73°F	8·2	5·561	22·752	22·752	·4206	72°F	7·4	Fish overturned and taken out
3–4	..	19·71	23·763	5·505	74°F	8·1	8·083	14·915	14·915	·686	75°F	7·2	Fish taken out
5 6	..	23·514	25·532	7·342	74°F	8·1	5·814	23 763	23·763	·229	74°F	7·3	Fish overturned and taken out
7–8	..	23·514	25·532	5·79	74°F	8·1	4·769	25·785	25·785	·274	72°F	7·5	Do.
9–10	..	19·71	23·763	5·505	74°F	8·1	1·769	23·257	23·257	·703	75°F	7·6	Fish quite comfortable and taken out
11–12	..	22·75	25·785	6·33	73°F	8·2	3·539	25·027	23·027	·371	74°F	7·3	Fish overturned and taken out

conducted in May, the temperature ranged from 82° F. to 87° F. The fry when introduced into the container were allowed to rest for five minutes because breathing was rapid in the beginning due to exertion as the fish darted from one corner to another before they settled down. Sufficient care was taken by the observer to be unnoticeable to the fish as a slight noise or movement would make the fish dart and strike against the container. A control was kept during the period of experimentation. The experiments were started at the same time each day.

RESPIRATORY MOVEMENTS

The rate of respiratory movements per minute in the two species is shown in Table I. The gaseous contents of the medium, its temperature and its pH value for the experiments when the temperature ranged from 72° to 75° F. are given in Table II. It was observed that the rate of respiration, when the temperature was low, was slow and the fish lived in the medium from 145 to 205 minutes. But when the temperature ranged from 82° to 87° F. the breathing, even from the commencement of the experiment, was quite rapid and most of the fish did not survive after 125 minutes and only a few lived upto 145 minutes.

The tests, further, showed that with the reduction of oxygen in the medium there was a gradual increase in the respiratory movements of the fish. With further decrease in the oxygen the movements showed a decline which ultimately ended in the suffocation of the fish. The fish, taken out of the container immediately when the fall in the respiratory movements was noticed, revived when put in fresh water, but those left in the container overturned and died.

It may, therefore, be said that upto a certain limit, *i.e.*, 0·686 c.c. p.l., dimunition in the dissolved oxygen in the medium is tolerated by the fish irrespective of cabon dioxide concentration, and its respiratory movements increase to compensate for the lack of oxygen. But when the oxygen is reduced to 0·229 to 0·371 c.c. p.l. in the medium the respiratory movements slow down and ultimately result in the asphyxiation of the fish.

Office of the Game Warden,
Punjab, Lahore, HAMID KHAN.
October 19, 1943. AMJAD HUSAIN.

1. Belding, D. L., *Trans. Amer. Fish. Soc.*, 1929, **59**, 238–45. 2. Hamid Khan, *Ind. Journ. Vet. Sci. Anim. Husb.*, 1940, **10**, 372–81.

GROWTH STAGES OF *LYSIOSQUILLA TIGRINA* NOBILI

THE present communication is a continuation of the studies on the Stomatopod larvæ of the Madras Coast already published in *Current Science* (Alikunhi and Aiyar, 1942, '43). *Lysiosquilla tigrina* Nobili is a very rare species, and to my knowledge is known only from the type specimen. Nobili obtained a single male specimen, 45 mm. long, from Santubong, Borneo, which was redescribed by Kemp (1913). The larvæ of this species are very rare as only two specimens could be obtained, one picked out from the preserved plankton of 14-3-1939 after an examination of seven years' plankton collections and the other obtained in the living condition from plankton of 3-3-1943. The latter developed into a female.

Final Pelagic Larva.—Total length including rostrum 13·5 mm., length of rostrum 4·3 mm., median length of carapace, excluding rostrum 4·5 mm., breadth of carapace in front of postero-lateral spines 2·3 mm., length of postero-lateral spine 3·2 mm., length of telson 1·3 mm., breadth of telson 1·7 mm.

Carapace slightly broader than the abdominal segments and extends over first abdominal. Antero-lateral corners smooth without any indication of the antero-lateral spines (Fig. 1*a*). Zoea spine absent. Rostrum long, with three ventral spinules. Tips of postero-lateral spines reach hind end of telson; each spine with a ventral spinule at base. Antennular peduncles short, flagella hardly reaching middle of rostrum. Eyes large with short eyestalks. Raptorial propodus with a short stout spine proximally. Dactylus has no free spines besides the terminal. 'Hands' of the third and fourth thoracic appendages large; that of fourth

about twice the size of that of third. Abdominal segments very much broader than long; postero-lateral corners smooth and rounded. Telson broader than long with broad submedian area. Of the three pairs of marginal spines the submedians are the largest (Fig. 1b). One lateral and two intermediate denticles present on each side. The submedian area is marked out into three regions. Five small

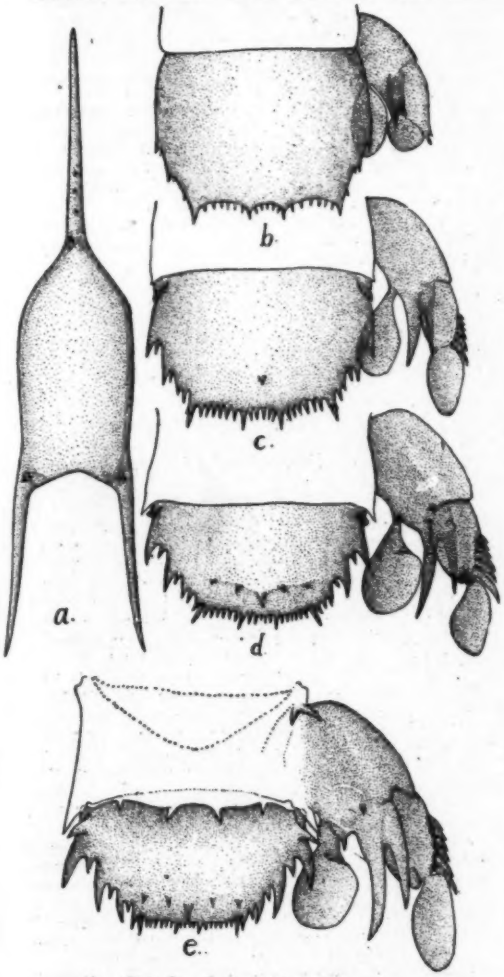


FIG. 1. *Lysioquilla tigrina*

(*a*) Carapace of Final Pelagic Larva × 10; Telson and Uropod of; (*b*) Final Pelagic Larva × 25, (*c*) Early Post Larva × 25; (*d*) Young specimen after first moult × 25; (*e*) Same after 2nd moult ×25; (Diagrams made with camer lucida).

denticles in the central area and six in each of the lateral areas are present (6 + 1 + 5 + 1 + 6). Exopod carries two free spines; outer spine of ventral prolongation smaller than the inner.

Colouration.—Carapace with two pairs of yellow pigment spots, first pair at the level of the raptorial limbs and the second near the base of the postero-lateral spines. 'Hands' of third and fourth thoracic limbs bright yellow. Sixth abdominal segment with a small group of yellow chromatophores on either side at the base of uropod.

The absence of the zoea spine and the antero-lateral spines of the carapace, the number and arrangement of the submedian denticles of telson are features that distinguish this form from allied Lysierichthii. The post-larval stage is reached overnight after rapid moulting and metamorphosis.

Early Post-Larva.—Total length 9 mm. It is a pale-white actively swimming creature. There is a slight reduction in length consequent on the shortening of the thoracic region during metamorphosis. Eyes prominent; rostrum bluntly pointed; raptorial dactylus with 10-11 teeth. Sixth abdominal somite with small sub-acute spines at postero-lateral corners. Telson has become shorter; with marginal spines long and pointed. Submedian spines movably articulated. Intermediate denticles three in number. Submedian denticles same as in larva. A single median dorsal spine near distal margin of telson (Fig. 1c). Uropod longer than in larva with six spines on outer aspect of basal segment of exopod; Outer spine of ventral prolongation a trifle shorter than the inner.

Eight moults were observed, the first being eight days after metamorphosis, the whole time being 81 days, after which the specimen died. The intervals between the moults were 8, 7, 7, 10, 10, 12 and 19 days respectively. The length of specimen after each moult was 11, 13, 15, 18·5, 22, 25, 28·5, 29·7 mm. respectively. During the moults the carapace, abdomen, telson and uropod are the structures affected as shown by the change of shape of rostrum, the increase in the number of spines at the hind inferior border of the last abdominal segment and the development of the spines characteristic of the adult on the sides of the telson. Figs. 1d and 1e show some of these changes. The colour pattern so characteristic of the species is indicated after the second moult in the form of three transverse bands on the carapace, by an inconspicuous brown transverse band on each of the last four thoracic segments and on each of the first four abdominal segments. After the third moult colour pattern becomes better defined. Gradually the bands on the exposed thoracic segments become wider and the anterior pigment bands of some of the abdominal segments more clear, while there is a tendency for the bands to fuse, which becomes more pronounced in subsequent moults.

Fuller details will be given in a comprehensive paper under preparation.

My grateful thanks are due to Prof. R. Gopala Aiyar for his valuable help and criticism. I am also indebted to Prof. P. Narayana Menon and Messrs. M. Krishna Menon and R. Velappan Nair for their helpful suggestions.

University Zoology Research Laboratory, Madras,
Dept. of Natural Science,
Maharaja's College, Ernakulam,
December 10, 1943. K. H. ALIKUNHI.

Alikunhi, K. H., and Aiyar, R. G., "On some *Squilla* larvæ from the Madras Plankton," *Curr. Sci.*, 1942, **11**, No. 2; "Growth in Some Stomatopods", *Curr. Sci.*, 1943, **12**, No. 3; Kemp, S., "An Account of the Crustacea Stomatopoda of the Indo-Pacific Region," *Mem. Ind. Mus.*, 1913, **4**.

REVIEWS

Modern Synthetic Rubbers. By Harry Barron. (Chapman and Hall Ltd., London), 1942. Pp. viii + 274. Price 25/-.

The appearance of this book is most opportune. With the rubber cultivation of the world in enemy hands, the need for a synthetic rubber industry in Great Britain and in the Empire, particularly in India, is most vital. Dr. Barron has, therefore, rendered yeoman service by bringing out this book and although the get-up of the book and the treatment of the subject-matter could have been better, the fact that "all too often the pen has to be laid aside at the behest of the more urgent and irresistant call of the air-raid siren" explains fully that war-time economy and the strife of life under war conditions are responsible for the minor shortcomings one notices. The book is one which ought to be in all scientific and technical libraries and in the hands of all workers interested in rubber and plastic materials in general. As is well known to workers in these fields, the meanings attached to the word rubber have changed. Rubber no longer signifies merely a particular hydrocarbon material. In order to qualify as a rubber, the material should be able to be stretched readily to a considerable degree and after release return forcefully and quickly to almost its original size and shape.

The contents of the book have been divided into three parts. Part I deals with general considerations regarding natural rubber and synthetic-rubber-like materials. Part II takes into consideration the chemical and physical background of synthetic elastic materials and includes in it the question of terminology, historical background, chemical behaviour and structure of natural and synthetic rubber, raw materials, polymerisation, copolymerisation and emulsion and polymerisation.

Part III deals with the technology of synthetic elastic materials and elastomers; *S.K.B.* and *Bunas, perbunan, hycar O.R. chemigum* and *neoprene* have been fully dealt with. Polybutylene and butyl rubber are treated under the title "Elastenes". This is a new word coined by the author to denote the materials employed for the manufacture of rubber-like substances which are based on olefines and are virtually saturated. Thioplasts and ethenoid elastics have been given adequate treatment occupying 34 pages of the book (213-247). A whole chapter has been devoted to comparative properties of elastics which makes the book exceedingly useful from the practical point of view. These properties have been fully explained and in some cases, they are even diagrammatically brought out. A table has been provided to bring out the property of chemical resistance at 20° C. and is of great value to those who are interested in the application of synthetic rubber to container-problems.

The most remarkable feature of the book is the rather up-to-date information on the physical properties of the synthetic rubber. The X-ray diagrams showing the structure in the stretched and unstretched condition are excellent, and are a great help in understanding the fundamental properties of synthetic rubber. It would have been useful if the author devoted a few pages to numerous plants other than the usual one from which the rubber latex is collected. This has been omitted largely because the treatise really deals at great length only with synthetic rubbers.

The reviewer is of the opinion that the synthetic rubbers have come to stay. Several properties which they possess make them indispensable to trade and industry. It will be a wrong policy for the British people and for us in India not to devote more attention to synthetic rubber because we can grow natural rubber. The natural rubber itself can be improved by admixture with plasticisers and synthetic rubber.

I must end by congratulating the author for producing this extremely useful and readable volume. The subject-matter is treated accurately and is not too difficult for a works-chemist who may not be familiar with the latest physical and chemical technique.

S. S. B.

A Junior Book of Physical Chemistry. By Dr. I. D. Shiva Rao. (Published by Jayantilal Vithaldas, Surat), 1943. Pp. 220 + vi + 7. Price Rs. 5.

The book is written primarily for the use of B.A. (HONS.) and B.Sc. (SUBS.) students of the Bombay University. The book is divided into eleven chapters; each chapter begins with a short summary of the main topics of the section and ends with a list of questions that have appeared on these topics at the Bombay University examinations. Throughout the author's ambition has been to coach up the student for the examination and in fact this book can be said to be his lecture notes in print.

In the opinion of the reviewer the value of the book can be considerably enhanced by drawing the attention of the author to the following points:—

(1) The printing is far from satisfactory. In several places (pp. 18, 19, etc.), 'degree' mark appears on serial numbers as though they represent temperature. The figures must be numbered and their neatness improved.

(2) It is highly desirable that standard symbols for absolute temperature, etc. (p. 27), should be employed to avoid confusion.

(3) A detailed account of certain elementary portions like Dalton's atomic theory, laws of chemical combination, Avogadro's hypothesis, vapour density determination, etc., may be omitted.

(4) Greater details about electro-chemistry —ppn. of conductivity water, transport numbers, etc.,—would be very necessary as these portions will be learnt by the student for the first time.

(5) If the cost of the book is reduced further, greater section of the student population can reap the benefit of the labours of the author.

M. R. A.

SCIENCE NOTES AND NEWS

Inaugurating the first Joint Session of the Indian Academy of Sciences, and the National Academy of Sciences, India, held in Hyderabad (Deccan), H. H. the Prince of Berar said: "Your efforts in the field of science will, I feel sure, help India to join in overcoming the forces of aggression and in marching with steady step towards peace and prosperity. You have done much to give India a prominent place in the scientific world and I am sure you will meet with further success in solving the mysteries of Nature and in using her gifts for the progress of mankind."

Welcoming the Fellows and delegates of the Joint Session of the Indian Academy of Sciences and the National Academy of Sciences, India, held in Hyderabad, Md. Abdur Rahman Khan, President of the Hyderabad Academy, said:—

"In these days of ultra-specialisation it is impossible for any one man to appreciate fully the deliberations of the various sections in which the activities of the Science Academies here assembled will be conducted. Allow me, however, to point out that, through your brilliant researches and epoch-making discoveries you have given India the foremost place in the domain of Academic activity in Asia. To Sir C. V. Raman, in particular, to Sir P. C. Ray, Professors Saha, Birbal Sahni, Bhatnagar, Krishnan and Bhabha and a host of others, we are indebted for placing India in the forefront of international renown. We are looking forward to your contributions in post-war reconstruction schemes to such important branches of Applied Science as aeronautics, navigation, military and marine engineering, industrial and biochemistry, etc., which will make India a self-contained and self-supporting unit in the galaxy of progressing nations.

"Civiliaztion owes a tremendous debt to the early astronomers of Egypt, Babylonia, Assyria and China; to the savants of ancient Greece (mostly through the institution of Plato's Academy in the modest grove of Academus in Athens, hence the name Academy which we are all proud to adopt), to the all-round contributions of Arab intellect and to Hindu mathematics and medicine.

"Our present experience has brought home to us all too plainly the inadequacy of purely scientific investigations, unleavened or modified by philosophical contemplation and philanthropic conceptions, treating the whole human race as a single entity, undifferentiated by artificial distinctions of caste, colour, creed or nationality. India, the land of Gautama Buddha and Amir-Khusrau, may yet be able to bring the world back to Peace and Plenty, Co-operation, Contentment and Universal Happiness, through the practice and preaching of its God-fearing and man-loving philosophers. Let us pray that this goal is not far off and we shall soon witness its blessings spread all over the globe, as was done on more than one occasion in the past.

"Coming down to more local matters, I have a more mundane, and to a large extent, personal message to offer. Having retired from Government service, I was abruptly cut off from the experimental world; but human mind easily adapts itself to environment. I found ample scope for incessant work in the pursuit of observational astronomy, like the determination of meteor radiants, the significance of moon-lit meteors and the drift of long-enduring trains, disclosing the presence of strong convection currents in the upper atmosphere; and the equally interesting study of Variable Star phenomena. To calculate the heights and orbits of exceptionally bright meteors and make a systematic study of their spectra, a number of keen observers provided with suitable apparatus and scattered over different parts of the country, are needed. Harvard and Yale, the British Astronomical Association, the Flower Astronomical Observatory of Pennsylvania, the University of Toronto, Canada and the Sternberg Astronomical Institute of Moscow (to name only a few) are devoting more and more attention to these fascinating topics and publishing the results of their observation and research. May I take this opportunity to invite some of you gentlemen, with more leisure at your disposal, to participate in this movement and fill up the gap in our programme of scientific investigations?"

In the course of his welcome address to the delegates of the Thirty-first Session of the Indian Science Congress held at Delhi, Sir Maurice Gwyer said:

"Indian science has already achieved a position second to none in the world, and Indian men of science have it in their power to make a contribution to the future welfare of India almost beyond human computation. They can transform the face of India, they can multiply its wealth, they can solve the problems of ignorance and poverty; and who knows whether they may not even be able to solve the most intractable of all, India's constitutional problems? It is the earnest prayer of all who have the happiness and welfare of this country at heart that all these problems, surveyed in the calm and serene atmosphere of science by men consecrated to the search for truth and nothing but the truth, with minds free from prejudice or bias, may find a solution, or at least the beginnings of a solution, at the meetings this week in Delhi.

By the irony of circumstance, war, that great enemy of human progress, affords the most powerful stimulus to scientific research that we know; but good can come out of evil, as war is followed by peace; and that part of the world which still loves peace and still believes in human personality in the dignity of man and in honest dealing between nation and nation, will benefit hereafter from the labours of scientists to put new and ever more potent weapons in its hands to defeat the enemies of mankind. For those and for the many other

blessings which, by the goodness and mercy of God, men of science have bestowed upon us, we tender them our gratitude; and we hope that their labours this week and the discussions and contacts which a gathering like this makes possible will bear fruit a hundredfold.

In the course of his Presidential Address to the twenty-sixth session of the Indian Economic Conference held in Madras, Dr. B. V. Narayanaswamy Naidu said: "Hitherto the material resources of India have been mobilised for winning the war. The time has now come for us to realise that as so soon as the war is over, this mobilisation cannot be dropped but has to be reoriented for winning the greater victories of peace. It is up to us to realise, that we have to see to it that the war controls are carried on into peace-time and utilised by capable and sympathetic hands for the promotion of India's wealth and welfare. The aim should be steadily kept in view to bring about a maximum utilisation of the material and human resources of the vast sub-continent of India in the interests of all its inhabitants. Such a plan will lead to the providing for all Indians the minimum of necessaries like food, clothing, housing, medical help and education."

In any scheme of social welfare, provision for cheap, abundant and nourishing food should take the place of honour. Taking as basis a family of three adults and two children, the minimum annual food requirement for this unit would be Rs. 240, if we are to take Dr. Aykroyd's standard, while other essentials like fuel would demand an additional Rs. 120. According to this computation, every individual with a family requires Rs. 30 per mensem excluding contributions for social insurance. This would involve a provision for a total income of at least Rs. 3,000 crores a year. At the same time, it must be borne in mind that this is only the minimum; the average is bound to be higher and therefore in order to ensure the minimum to all, the national income will have to be many times this figure.

No effort should be considered too arduous, no expense too heavy for carrying into execution a comprehensive plan which will include both agriculture and industry. Whenever in the past a plea was made for nation-building activities, an old horse, named lack of capital, was trotted out by obscurantists. Where there is a will to bring about a new order in India, the way can surely be devised. If there is to be an easy transition from a war economy to a peace economy, if India's millions are not to be for ever starving, ignorant and suffering, a co-ordinated plan for industrial and agricultural development, is a prime need."

"Any planned scheme of economic development for India", proceeded Dr. Naidu, "must not be a slavish imitation of Western industry with its urban civilisation and perpetual clash of classes. Industry at the present day has reached a stage when it is dependent for its very existence and survival on the sympathy, encouragement and active support of the State. When a State like India wants to promote new industrial ventures, it can itself undertake the organisation, and see that it is worked in the interests of all the people. Even if new enterprises are entrusted to individual or corporate management, the State should insist that the benefits thereof flow equally to the whole community and are not utilised to promote the profits and interests of a few. In other words, the planned economy of post-war India must be so conceived and designed that surely and inevitably it will lead ultimately to a socialistic new order in India."

At the twenty-fourth session of the All-India Liberal Federation held in Bombay, the Federation adopted a resolution on post-war reconstruction. The resolution, referring to the Committees appointed by the Government of India and certain Provincial Governments for the purpose, emphasised that the main functions of such Committees would be to lay the foundations of a well-planned economy which would increase the cultivation of productive crops, improve agricultural methods, expand rural reconstruction and liquidate illiteracy. Among other essential requirements, the resolution continued, are the improvement and extension of communications and works of irrigation, the creation of an Indian mercantile marine, increased medical aid, the establishment of better health conditions, the provision of social services such as insurance against sickness and unemployment, and a general improvement in the standard of living.

The resolution further urged the Government to have a settled policy to assist in the establishment of new industries and in the development of the natural resources of the country; and pointed out the necessity, after the war, of the protection of nascent industries against foreign competition.

For the first time in its annals, a meeting of the Royal Society was held outside England, when Prof. A. V. Hill, on behalf of the President of Royal Society, admitted Dr. S. S. Bhatnagar and Prof. H. J. Bhabha to the fellowship of the Society.

As these distinguished scientists could not go to England on account of the war, the Royal Society empowered Prof. Hill to admit them by holding an extraordinary meeting attended by the delegates to the Indian Science Congress.

Prof. Hill on that occasion stated:

"This occasion is unique in the fact that, for the first time in its 281 years, the Royal Society is holding a meeting outside England."

Sir C. V. Raman has been re-elected President of the Indian Academy of Sciences for the period 1943-46 at the ninth annual session of the Academy held at Hyderabad. Dr. H. J. Bhabha, Dr. K. R. Ramanathan, Prof. Birbal Sahni and Lt.-Col. S. S. Sokhey were re-elected Vice-Presidents.

The following have been elected Fellows of the Indian Academy of Sciences at the Ninth Annual Meeting held at Hyderabad:—Major Inderjit Singh, Ph.D. (Cantab.), I.M.S., Officer-in-Charge, Brigade Laboratory, *Allahabad*. Dr. R. S. Krishnan, M.A., D.Sc., Physics Department, Indian Institute of Science, *Bangalore*. Prof. G. P. Majumdar, M.Sc., Ph.D., Professor of Botany, Presidency College, and Lecturer, Calcutta University, 19, Ekdalia Place, Ballygunj, *Calcutta*. Dr. G. V. L. N. Murty, D.Sc., Research

Chemist, Tata Iron and Steel Works, *Jamshedpur*. Prof. L. Narayan Rao, M.Sc., Ph.D. (Lond.), Professor of Botany, Central College, *Bangalore*. Dr. V. Ramaswami, B.A. (Cantab.), Ph.D. (Cantab.), Head of the Department of Mathematics, Andhra University, *Guntur*. Dr. K. L. Ramaswamy, D.Sc., Superintendent of Works, Mysore Chemicals and Fertilisers, Ltd., *Belgola*. Prof. K. P. Rode, M.Sc., Ph.D., Head of the Department of Geology, Andhra University, *Guntur*. Dr. U. Sivaraman Nair, M.A., Ph.D., Assistant Professor of Mathematics, University College, Trivandrum. Prof. K. Sreenivasan, B.Sc., A.I.I.Sc., M.I.E.E., Mem.I.R.E., Mem.A.I.E.E., Head of the Department of Electrical Technology, Indian Institute of Science, *Bangalore*. Prof. C. S. Venkateswaran, M.A., D.Sc., F.Inst.P., Professor of Physics, University of Travancore, *Trivandrum*.

Lady Tata Memorial Trust: Research Scholarships for 1944-45.—(1) Applications are invited for six Scientific Research Scholarships of the value of Rs. 150 per month each for the year 1944-45.

(2) The Scholarships are open to men and women, and will be tenable for a period of twelve months commencing from the 1st July 1944. Any or all the Scholarships may be extended for a further period of twelve months, within the discretion of the Trustees. All old scholars who desire renewal should re-apply.

(3) Applicants, who must be of Indian nationality, must be Graduates in Medicine or Science of a recognised University. They must undertake to work whole-time and will be debarred from private practice. In the duration of the period of his scholarship or award the recipient of the benefit shall devote himself to the work before him to the entire satisfaction of the Trustees, who reserve the right to withhold payment on the recommendation of the Advisory Committee.

(4) The subject of scientific investigation which they may select must have a bearing directly or indirectly on the alleviation of human suffering from disease.

(5) Applications must be forwarded through the Director of a recognised Research Institute or Laboratory where the candidate proposes to work and must be accompanied by a letter from the Director stating that he has critically examined the details of the proposed Research, that he approves of the general plan and that he is willing, as far as possible, to guide and direct the investigation and give laboratory facilities.

(6) Candidates will be required to furnish the following additional information in their application, along with certificates of physical fitness and character: (*a*) Full Name, (*b*) Age, (*c*) Sex, (*d*) Permanent Address, (*e*) Details of Academic Career, (*f*) Particulars of their past and present Research qualifications, (*g*) Particulars of the proposed Research, and (*h*) *What other emoluments, scholarships and pay or any other financial support from friends or relations they are or will be in receipt of during the period they are Scholars and the amount if any.*

(7) Applicants must give (*a*) a short resumé on the subject indicating present state of knowledge and (*b*) details of the proposed research indicating (*i*) the methods intended to be employed, (*ii*) previous experience in the use of these methods and (*iii*) the experiments to be carried out.

(8) Applications, which must be typed, must give full particulars in the order indicated above and must be addressed to the *Secretary, The Lady Tata Memorial Trust, Bombay House, Bruce Street, Fort, Bombay*, so as to reach him not later than 15th March 1944.

(9) Applicants are warned that any canvassing, direct or indirect, of the Trustees or Members of the Selection Committee, will entail disqualification, and also that the Scholarships are liable to be terminated without any notice on receipt of any unfavourable report from the Director under whom a Scholar may be working.

(10) The result of the selection will be announced on the 18th June 1944 and the successful candidates will be required to report themselves for duty, to their respective Directors, on the 1st July 1944.

(11) Scholars will be required to submit periodical progress reports every six months to the Secretary of the Trust, through the Directors and with their remarks of the work done.

Indian Mathematical Society: The Narasinga Rao Medal for Mathematical Research.—The Indian Mathematical Society has instituted a medal for the encouragement of mathematical research endowed by Dr. A. Narasinga Rao of the Annamalai University. The medal will be awarded to the best solution or contribution towards the solution of a specified problem in mathematics. A period of at least eighteen months will be given for the submission of theses dealing with the problem and the award will be made at the Conference of the Indian Mathematical Society which meets immediately after its adjudication. To be eligible to compete for the medal, the competitor must be of Indian domicile and must be a member of the Indian Mathematical Society at the time of submitting the thesis and at the time of award. There is no entrance fee.

One of the objects of the award is to direct the attention of younger researchers in India to modern topics in mathematics which have not so far received their due share of attention.

Particulars regarding the first prize problem under the above endowment which was selected by a special committee at the Annamalainagar Mathematical Conference, can be had from the Secretary.

Theses connected with the problem should be sent to Dr. A. Narasinga Rao so as to reach him before the end of July 1945.

The Syndicate of the University of Utkal has accepted a sum of Rs. 7,000 donated by the Public Utility and Charitable Fund of the district, towards the establishment of a university library.

A Possible Reprinting of Saccardo's *Sylloge Fungorum*.—The Alien Property Custodian has recently announced (*Science*, 1943, 97, 303-4) that many technical books and sets of books of Axis origin are available for republication. The procedure to be followed in obtaining necessary licences and other details is given

and it is clear that every encouragement will be given to bring about prompt reproduction of books of this kind.

To mycologists and plant pathologists this announcement immediately suggests the possibility of the reproduction of Saccardo's classical *Sylloge Fungorum* in usable form. This compendium of mycological descriptions is a *sine qua non*, and the comparatively few sets now in use in the Americas are showing the effect of much use. Additional copies have been practically non-existent heretofore, only occasional sets appearing on the market at rare intervals and at exorbitant prices. There are undoubtedly many institutions as well as individual mycologists and plant pathologists who will welcome an opportunity to purchase a set of Saccardo. Even those libraries now possessing the work will likely desire an additional set to relieve the wear and tear on the original.

It has been ascertained that a satisfactory reproduction of the 25 volumes can be produced. If 100 subscriptions are obtained by September 1, the complete set of 25 volumes can be obtained at $200.00 per set; if 300 subscriptions are obtained, the price will be $150.00 per set. These prices are based on an offset edition, with the type block photographically reduced ten per cent.

In order that the undersigned may obtain an idea of the number of prospective purchasers, interested mycologists are requested to send in tentative subscriptions and to interest their respective institutions in doing likewise.

Bureau of Plant Industry
Station, Beltsville, Maryland. JOHN A. STEVENSON.

It is understood that the Government of India will soon constitute an industrial commission consisting of about ten prominent industrialists who will undertake an extensive tour of the United Kingdom and the United States of America in order to study the development of industries and discuss ways and means by which their war-time industries will be changed to fit the peace-time economy during the post-war period.

The Government of India have appointed a committee, under the chairmanship of Mr. D. V. Rege, I.C.S., to report upon a "Beveridge Plan" for industrial workers during the post-war period.

A complete assembly for the manufacture of sugar on a cottage industry scale, has been designed and constructed at the Sugar Research and Testing Station, Bilari. The plant can be operated by the grower with the aid of his family and his bullocks. Besides yielding a higher return for the labour involved, the sugar manufactured with this plant is free from excise duty as no motive power is employed.

The Government of Mysore have decided to organise the Sericulture Industry in the State on a more stable basis. In this, they are to take advantage of the prevailing absence of competition from China and Japan and the consequent rise in the price of silk, for the benefit of the industry. The Silk Control Order which has been recently promulgated seeks to further the war effort and secure the permanent advance of the industry. A third of the net profits realised by the sale of silk in the State is earmarked for researches directed towards the consolidation and expansion of the industry.

Benares Hindu University.—Mr. C. Dakshinamurti has been awarded the D.Sc. of the Benares Hindu University, in Physics, at the Convocation held on the 28th November 1943 for his thesis "Doppler Effect in Positive Rays of Hydrogen, etc."

MAGNETIC NOTES

Magnetic conditions during December 1943 were slightly less disturbed than in the previous month. There were 11 *quiet* days, 19 days of *slight* disturbance and 1 day of *moderate* disturbance as against 16 quiet days, 13 days of slight disturbance and 2 days of moderate disturbance during the same month last year.

The quietest day during December 1943 was the 6th and the day of the largest disturbance the 16th.

The individual days during the month were classified as shown below.

Quiet days	Disturbed days	
	Slight	Moderate
6–8, 11–13, 15, 24, 27, 28, 30.	1–5, 9, 10, 14, 17–23, 25, 26, 29, 31.	16

No magnetic storms occurred during the month of December in the years 1942 and 1943.

The mean character figure for the month of December 1943 was 0·68 as against 0·55 for December 1942.

M. V. SIVARAMAKRISHNAN.

We acknowledge with thanks the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 91, Nos. 4651, 4652.

"Annals of Biochemistry and Experimental Medicine," Vol. 3, No. 2, 1943.

"Calcutta Review," Vol. 89, No. 2; and Vol. 90, No. 1.

"Journal of the Indian Chemical Society," Vol. 20, No. 10.

"Chemical Products and Chemical News," Vol. 6, Nos. 9 to 12.

"Indian Farming," Vol. 4, No. 7.

"Transactions of the Faraday Society," Vol. 39, Pts. 9 and 10.

"Indian Forester," Vol. 70, No. 1.

"Central Board of Irrigation (Bulletin)," No. 1, Oct. 1943.

"Indian Trade Journal," Vol. 151, Nos. 1956, 1958; Vol. 152, No. 1959.

"Monthly Science News," No. 27.

SUPPLEMENT TO CURRENT SCIENCE

Vol. XIII] INDIAN SCIENCE CONGRESS, DELHI, 1944 [No. 1

Summaries of Addresses of the Congress President and Presidents of Sections

PRESIDENTIAL ADDRESS

Congress President: PROFESSOR S. N. BOSE

THE CLASSICAL DETERMINISM AND THE QUANTUM THEORY

I WOULD like to present before you certain aspects of modern physics and draw your attention to the profound changes in the principle of scientific explanation of natural phenomena brought about by the quantum theory. The last fifty years record remarkable discoveries. These discoveries have their repercussions in the realm of ideas. Fifty years ago the belief in causality and determination was absolute. To-day physicists have gained knowledge but lost their faith. To understand properly the significance of such a profound change it will be necessary to discuss briefly how it all came about. Classical physics had begun with the study of astronomy. Physicists had taken the equations of celestial mechanics as their model of a universal law. Since matter had resolved into a conglomeration of particles, the ideal scheme was to explain all phenomena in terms of their motions and interactions. It was only necessary to set up a proper set of equations, and to take account of all possible mutual interactions. If the mass, position, and velocity of all the particles were known at any instant, these equations would theoretically enable the physicist to predict the position and motion of every particle at any other subsequent moment.

The phenomena of light did not at first fit into this simple scheme. With the discovery of the electron as a universal constituent of matter, the electromagnetic theory of Maxwell was converted into an electronic theory by Lorentz. To the dynamical laws were added the electromagnetic equations and the two together apparently gave an exact and ideal formulation of the laws of causality. It was more or less a matter of faith to maintain that if it were possible for us to obtain all the necessary data by delicate observations, universal laws would enable us to follow each individual molecule in this intricate labyrinth and we should find in each case an exact fulfilment of the laws and agreement with observation. The above in brief forms an expression of faith of a classical physicist. We see that it involves as necessary consequences, belief in continuity, in the possibility of space-time description of all changes and in the existence of universal laws independent of observers which inexorably determine the course of future events and the fate of the material world for all times.

II

The development of the quantum theory has raised fundamental issues. Facts have been discovered which demonstrate the breakdown of the fundamental equations which justified our belief in determinism. A critical examination of the way in which physical measurements are made has shown the impossibility of measuring accurately all the quantities necessary for a space-time description of the motion of the corpuscles.

Experiments reveal either the corpuscular or the wave nature for the photon or the electron according to the circumstances of the case, and present us with an apparently impossible task of fusing two contradictory characters into one sensible image. The only solution suggested has been a renunciation of space-time representation of atomic phenomena and with it our belief in causality and determinism.

Let me briefly recapitulate the facts. In 1900 Planck discovered the quantum of action while studying the conditions of equilibrium between matter and the radiation field. Apparently interchange of energy took place in discrete units whose magnitude depended on h and the frequency of the radiation emitted or absorbed by matter. Photo-electric emission had similar disquieting features. Einstein, therefore, suggested a discrete structure of the radiation field in which energy existed in quanta instead of being continuously distributed in space as required by the wave-theory. This light-quantum, however, is not the old light-corpuscle of Newton. The rich experimental materials supporting the wave-theory preclude that possibility altogether. Moreover the fundamental relation, $E = h\nu$, and $p = hk$, connecting energy and momentum of the photon with the frequency ν and the vector wave number k, makes a direct reference to idealised plane wave so foreign to the old idea of a corpuscle. Soon afterwards Böhr postulated the existence of radiationless stationary states of atoms and showed how it led to a simple explanation of the atomic spectra. The extreme simplicity of the proposed structure and its striking success in correlating a multitude of experimental facts at once revealed the inadequacy of the ordinary laws of mechanics and electro-dynamics in explaining the remarkable stability of the atoms.

The new ideas found application in different branches of physics. Discontinuous quantum processes furnished solutions to many puzzles. Suitably modified, the theory furnished a reasonable explanation of the periodic classification of elements and thermal behaviour of substances at low temperature. There was, however, one striking feature. It was apparently

impossible to characterise the details of the actual transition processes from one stationary state to another, that is, to visualise it as a continuous sequence of changes determined by any law as yet undiscovered. It became clear that the dynamical laws as well as the laws of electromagnetism failed to account for atomic processes. New laws had to be sought out compatible with the quantum theory capable at the same time of explaining the rich experimental materials of classical physics. Böhr and his pupils utilised for a time a correspondence principle, guessing correct laws for atomic processes from analogy with the results of the classical theory. In every case these appeared as statistical laws concerned with the probabilities of transition between the various atomic states. Einstein tackled the problem of the equilibrium of matter and radiation on the basis of certain hypotheses regarding the probabilities of transition between the various states by absorption and emission. A derivation of the Planck Law was obtained by Bose by a suitable modification of the methods of classical statistics. Heisenberg finally arrived at a satisfactory solution and discovered his matrix-mechanics and a general method for all atomic problems. Dirac and Schrödinger also published simultaneously their independent solutions. Though clothed in apparently dissimilar mathematical symbols, the three theories gave identical results and have now come to be looked upon as different formalisms expressing the same statistical laws.

I have mentioned that the photon gave a simple explanation of many of the properties of radiation and thereby presented its corpuscular aspect while the well-known properties of interference and superposibility brought out its wave character. That the same dual nature may exist in all material corpuscles was first imagined by De Broglie. His phase-waves found quick experimental verification, and raised a similar problem of the real nature of the corpuscle. The formulation of wave-mechanics by Schrödinger, once raised a hope that by a radical modification of our usual ideas about the corpuscle it might be possible to re-establish the law of causality and classical determinism. Subsequent developments have shown such hopes to be illusory. His waves are mathematical fictions utilising the multidimensional representation of a phase-space and are just as incapable of explaining the individuality of the electron, as the photon is incapable of explaining the superposibility of the field. The true meaning of his equations appears in their statistical interpretation.

III

The adherents of the quantum theory interpret the equations in a peculiar way. They maintain that these equations make statements about the behaviour of a simple atom and nothing more than a calculation of the probabilities of transition between its different states is ever possible. There is nothing incomprehensible about such a statistical law even if it relates to the behaviour of a single particle. But a follower of determinism will interpret such statements as betraying imperfect knowledge, either of the attendant circumstances or of the elementary laws. We may record the throws when a certain die is cast a large number of times and arrive at a statistical law which will tell us how many times out of a thousand it will fall on a certain side. But if we can take into account the exact location of its centre of gravity, all the circumstances of the throw, the initial velocity, the resistance of the table and the air and every other peculiarity that may affect it, there can be no question of chance, because each time we can reckon where the die will stop and know in what position it will rest. It is the assertion of the impossibility of even conceiving such elementary determining laws for the atomic system that is disconcerting to the classical physicist.

Von Neumann has analysed the statistical interpretation of the quantum mechanical laws and claims to have demonstrated that the results of the quantum theory cannot be regarded as obtainable from exact causal laws by a process of averaging. He asserts definitely that a causal explanation of quantum mechanics is not possible without an essential modification or sacrifice of some parts of the existing theory.

Böhr has recently analysed the situation and asserted that we cannot hope any future development of the theory will ever allow a return to a description of the atomic phenomena more conformable to the ideal of causality. He points out the importance of the searching analysis of the theory of observation made by Heisenberg, whereby he has arrived at his famous principle of indeterminacy. According to it, it is never possible for us to determine the simultaneous values of momentum, and positional co-ordinates of any system with an accuracy greater than what is compatible with the inequality

$$\triangle p \, \triangle q > \frac{h}{4\pi}.$$

This natural limitation does not affect the physics of bodies of finite size but makes space-time descriptions of corpuscles and photons impossible. When we proceed to study the behaviour of the elementary particles, our instruments of measurement have an essential influence on the final results. We have also to concede that the contributions of the instrument and the object, are not separately computable from the results as they are interpreted in a classical way with the usual ideas of co-ordinate and momentum accepting thereby a lack of control of all action and reaction of object and instrument due to quantum effects.

It is in this imperative necessity of describing all our knowledge with the usual classical ideas, that Böhr seeks an explanation of the apparently irreconcilable behaviour of corpuscles and radiation in different experiments. For example, if we set our experiments in such a fashion as to determine accurately the space-time co-ordinates, the same arrangement cannot be simultaneously used to calculate the energy momentum relations accurately; when our arrangements have pushed the accuracy of determining the positional co-ordinates to its utmost limit, the results evidently will be capable only of a corpuscular representation. If, on the other hand, our aim is to determine momentum and energy with the utmost accuracy, the necessary apparatus will not allow us any determination of positional co-ordinates

and the results we obtain can be understood only in terms of the imagery of wave-motion. The apparently contradictory nature of our conclusions is to be explained by the fact, that every measurement has an individual character of its own. The quantum theory does not allow us to separate rigorously the contribution of the object and the instrument and as such the sum total of our knowledge gained in individual cases cannot be synthesised to give a consistent picture of the object of our study which enables us to predict with certainty its behaviour in any particular situation. We are thus doomed to have only statistical laws for these elementary particles and any further development is not likely to affect these general conclusions.

It is clear that a complete acceptance of all the above conclusions would mean a complete break with the ancient accepted principles of scientific explanation. Causality and the universal laws are to be thrown simultaneously overboard. These assertions are so revolutionary that, no wonder, they have forced physicists to opposing camps. There are some who look upon causality as an indispensable postulate for all scientific activities. The inability to apply it consistently because of the limitations of the present state of human knowledge would not justify a total denial of its existence. Granted that physics has outgrown the stage of a mechanistic formulation of the principle, they assert that it is now the task of the scientists to seek for a better formulation. Others of the opposing camp look upon old determinism as an inhuman conception, not only because it sets up an impossible ideal, but also as it forces man to a fatalistic attitude which regards humanity as inanimate automata in the hands on an iron law of causation. For them the new theory has humanised physics. The quantum statistical conception of determinism nestles closer to reality and substitutes a graspable truth for an inaccessible ideal. The theory has brought hope and inspired activity. It constitutes a tremendous step towards the understanding of nature. The features of the present theory may not all be familiar but use will remove the initial prejudice. We are not to impose our reason and philosophy on nature. Our philosophy and our logic evolve and adjust themselves more and more to reality.

In spite of the striking success of the new theory, its provisional character is often frankly admitted. The field theory is as yet in an unsatisfactory state. In spite of strong optimism, difficulties do not gradually dissolve and disappear. They are relegated to a lumber room, whence the menace of an ultimate divergence of all solutions neutralises much of the convincing force of imposing mathematical symbols. Nor is the problem of matter and radiation solved by the theory of complementary characters. Also we hear already of the limitations of the new theory encountered in its application to nuclear problems.

The quantum theory is frankly utilitarian in its outlook; but is the ideal of a universal theory completely overthrown by the penetrating criticism of the nature of physical measurements?

Böhr has stressed the unique character of all physical measurements. We try to synthesise their results and we get probabilities to reckon with instead of certainties. But how does the formalism $\frac{h}{2\pi i}\frac{\partial\psi}{\partial t} = H\psi$ emerge as a certain law? The wider the generalisation, the less becomes the content. A universal law would be totally devoid of it. It may nevertheless unfold unsuspected harmonies in the realm of concept. More than ever now, physics does need such a generalisation to bring order in its domain of ideas.

M. A. G.

CHEMISTRY

President: Dr. R. C. Ray, D.Sc., F.I.C.

SOME ASPECTS OF MODERN INORGANIC CHEMISTRY

THERE are many who think that there is no future for inorganic chemistry, except in its application to industry. It is generally assumed that inorganic chemistry has progressed as far as it could with the tools at hand. The discovery of the inert gases of the atmosphere by Ramsay and his co-workers and practically all the missing elements seems to have added the last chapter to inorganic chemistry; and one may really wonder what is there left to be done. The accumulated treasures, no doubt, seem marvellous, but as each year rolls by we find ourselves, like Balboa, looking down from the mountain top, beholding an infinite and beautiful expanse, yet unfathomed. The vista continues to widen, and new problems, new theories, new view-points loom large before us.

The possibility of compound formation by the inert gas was first suggested by Villiard, who found that crystalline hydrates were formed when the inert gases admixed with water, were cooled under pressure. The structure of these hexahydrates would seem to be similar to that of the co-ordination compounds of the cobaltamine type. The recent work of Nikitin in U.S.S.R., have established the formation of $Rn.2C_6H_5OH$ and $Xe.2C_6H_5OH$ corresponding to $H_2S.2C_6H_5OH$ or $HCl.2C_6H_5OH$. Booth and Wilson have also obtained and studied the formation of $A.6BF_3$. The formation of these co-ordination compounds of inert gases opens up an interesting field of research, and a considerable amount of work still remains to be done in this direction. The formation of such compounds by the higher atomic weight inert gases is permitted also by theoretical considerations, which indicate besides that the other lighter inert gases may also form compounds after excitation. Thus while Helium does not form co-ordination compounds of the type mentioned, it is apparently capable of combining with mercury in presence of electric glow discharge at low pressures. The formation of several other helides such as WHe_n, etc., by the reaction of excited He atoms, has also been reported.

During the last thirty years, considerable progress has been made in the chemistry of Boron and its compounds, but a large amount of work still remains to be done, before adequate answers could be found for many questions which remain unanswered. The study of hydroborons and borohydrates has raised new

problems about the nature of the chemical bond. Six hydrides of Boron are now known and the recent work of Schlesinger and his school have advanced our knowledge about these highly unstable and greatly reactive substances. Two of these very interesting types of compound are borine carbonyl and the metalloborohydrides. The former is somewhat similar to volatile metal carbonyls. The metallic borohydrides are generally prepared by the action of diborane on the alkyl compounds of the corresponding metals. Lithium borohydride is a definitely salt-like substance and has been given the formula $Li^+ BH^-_4$, but the beryllium borohydride BeB_2H_8 is a highly volatile solid, and aluminium borohydride $Al.B_3H_{12}$ is a still more volatile liquid. The gradation of properties from the relatively high melting non-volatile and polar lithium borohydride to the low-melting, highly volatile and almost non-polar aluminium borohydride is very striking; while the properties of aluminium borohydride approach those of diborane itself, the properties of beryllium borohydride are intermediate between those of corresponding lithium and aluminium compounds.

The mechanism of hydrolysis of magnesium boride has been studied by Ray and co-workers with interesting results. Contrary to what has been generally supposed, no boric acid or magnesium borate is formed in the hydrolysis of magnesium boride by water or dilute acids, but $H_3B_3(Mg.OH)_3$ and $Mg_3B_2(OH)_6$. The aqueous extract is a strongly reducing solution containing $H_6B_2O_6$. This compound exists in 2 isomeric forms α and β, the most important difference between these being that while a molecule of the α-compound loses 4 atoms of hydrogen when treated with an acid, the β-compound yields only 2 atoms of hydrogen per molecule. The constitution of these isomeric borohydrates provides a very interesting study on the nature of chemical bonds, particularly considering that it is now generally admitted that any chemical bond is not the resultant of a pair of electrons nor even of all the electrons associated with the pair of bonded atoms, but of all the electronic forces in the molecule. It seems that the solution of the mystery of the nature of the chemical bond lies hidden in the chemistry of the inert gases and that of boron.

While the constitution and structure of most organic compounds have been worked out, analytically as well as synthetically, the same thing cannot be said about many inorganic compounds. For instance our knowledge about the metallic hydrides is still incomplete. It is well known that some rare-earth metals, zirconium, tantalum and titanium, form a class of hydrogen compounds in which there does not exist an exact stoichiometric relationship between the metal and the hydrogen atoms, and these are generally regarded as interstitial compounds. Some of these "hydrides", however, possess high values for their heats of formation, suggesting that there can be little difference in the nature of the chemical bond in a substance such as zirconium hydride, $ZrH_{1.98}$ (heat of formation = 38,900 cals.) and barium hydride, BaH_2 (heat of formation = 40,960 cals.). It is one of the puzzling features of this group of substances.

The list of topics can, of course, be made much larger and may well include fields of other investigations in which both experimental methods and relevant theories are still lacking. It is clear, however, from what has already been said, that there has probably never been a time when the prospects of inorganic chemistry were so promising as they are to-day.

M. A. G.

BOTANY

President: Dr. T. S. Sabnis

PROGRESS OF BOTANY WITH SPECIAL REFERENCE TO ECONOMIC PLANTS

THE science of plant breeding and genetics has played a dominant role in the creation of better crops. Mendel's laws of heredity gave impetus all over the world to apply them for the benefit of evolving varieties with desirable traits. The present-day sugar-beet with its trebled sugar content, Marquis wheat, Yeomen I and Yeomen II and Howard's Pusa varieties of wheat which are the best yielding strains, are the outcome of intensive work on breeding. Cytology has recently come to play an important part in plant breeding; desirable gene combinations have been made possible by a cytological study of the different varieties of plants and this study has helped further to induce fertility in sterile hybrids which is a source of setback in plant breeding. The potentiality of inducing polyploidy does not merely end in inducing fertility but a further application of this phenomenon has resulted in plants like tomato and maize with increased nutritive content.

The discovery of ecotypes or biotypes in a species has provided a larger arena for the breeder. It has been possible to evolve newer and better-yielding forms by a close study of the variations in the ecotypes and has a great application both for improving agricultural and forestry plants. The findings of Clements and his co-workers regarding the growth of plants in relation to their environmental factors, that qualitatively water is the most important and that quantitatively light and nutrients, is of immense help particularly in the improvement of grasslands and forage crops.

Photoperiodism and vernalization have given wonderful results particularly in the U.S.A. and Russia. The finding that the general effect of shortened illumination resulted in an earlier production of flowers, has become a boon to synchronising the flowering period of widely divergent varieties. This has a very important possibility of cross-fertilising them under normal conditions. Such a result has already been achieved by crossing Egyptian cotton with low boll with several South American cottons with large bolls but of short day and perennial habit. 'Light' treatment is finding use in India in the improvement of potato. Lysenko subjected certain seeds to various temperature treatments and found that the vegetative stage was greatly reduced and the flowering stage commenced very early. This finding has resulted in many varieties of winter wheats yielding good crop, which without vernalization would not ear when sown in spring.

Economy in time and energy of raising fresh

plants has been made possible by the application of growth hormones. Contributions from the Boyce Thompson Institute and the investigations of Zimmermann and Hithhcock have opened up the possibility of employing the application of growth hormones on a commercial scale particularly for the rooting of cuttings which prove difficult and seedlings which are too delicate and suffer considerable mortality in early stages. It is of particular interest to note that when seeds are treated with the hormones obtained from Rhizopus and Yeast, the reproductive phase of such plants commenced earlier, much in the same manner in the case of vernalized seeds.

The role of secondary elements like boron, manganese, etc., is shown to be of vital importance for successful growth and fructification. And this has helped to combat certain deficiency diseases also. Soil-less culture is finding popularity but its success depends upon much spadework which is still to be done. Breeding has again played a major part in evolving varieties resistant to certain diseases. Particularly in America and Canada great success has been achieved in breeding rust and smut-resistant individuals from existing varieties.

B. G. L. S.

ZOOLOGY AND ENTOMOLOGY

President: DR. VISHWA NATH

THE GOLGI APPARATUS

IN his Presidential Address to the Section of Zoology and Entomology Dr. Vishwa Nath has given a summary of the present position of the Golgi Apparatus, incorporating some of his own views regarding the form and function of this cytoplasmic structure. A very large number of papers have appeared since 1898 when first this apparatus was discovered by Golgi and to-day, we are able, to a certain extent, to marshal the great array of facts and observations that have accumulated about the form, composition and function of this body. It is now known that the Golgi apparatus is found in every type of animal cell (and in most plant cells) and instead of being artefacts as they were once believed to be, they are real and living bodies in the cell. But their form, however, is subject to great variation, depending, mostly, on the technique employed; and here, Dr. Nath holds the belief very fixedly and vehemently that they are spherical granules and never of any other form. All other forms,—networks, dictyosomes, batonettes and rods are, according to him, artefacts, a conclusion which he has arrived at from an examination of a variety of cells. In chemical composition, the Golgi bodies are fats linked with proteins. The protein probably occupies the outermost layer of the Golgi sphere. In comparison with mitochondria the Golgi bodies have relatively less protein than lipoids and also their specific gravity is less than that of mitochondria as shown by experiments with the centrifuge.

The function of the Golgi bodies is also manifold. They give rise to the acrosome in sperm formation, to fat in oogenesis and to secretory granules in gland cells. But the exact method of formation of these bodies is a subject of controversy. Dr. Nath holds the view that in all the three cases a direct transformation of the Golgi apparatus into the products takes place, while the majority of workers are of opinion that they are products of secretion of the Golgi apparatus. There appears to be a close relation between the Golgi bodies and the mitochondria as the recent work of Hirsch has shown and it is possible that the Golgi pre-substance which is the primordial Golgi material in the cell is the contribution by the mitochondria and probably also the nucleus and cytoplasm.

There really does not seem to be much use in debating at great length and with much heat the problem of the exact form of the Golgi apparatus or the precise manner in which the products are formed by it. Would it not be better to realise that this "most protean of all cytoplasmic inclusions" is, like the living protoplasm of which it forms part, capable of varied manifestations, expressing itself in a hundred forms, all different but all designed to the same end, of fulfilling their destiny?

B. R. S.

MEDICAL AND VETERINARY RESEARCH

President:

DR. K. V. KRISHNAN, M.R.C.P., D.B., D.SC., F.N.I.

MEDICAL EDUCATION

IN his Presidential Address, Dr. Krishnan has laid stress on the great and urgent need for the proper training of the skilled medical men, a fundamental and vital question of the country. In spite of the progress and achievement of the last hundred years, he remarks, there is ample scope for further improvement and expansion in several directions. On the standard of the medical education reached in any country, Dr. Krishnan says, largely depends the soundness of medical men, the efficiency of medical service provided by the Government and its usefulness to the community.

In India we have a dual standard of medical education—lower and higher. The lower standard had to be instituted chiefly for economic reasons and as an interim expediency in the evolution of medical education. But it is now felt in India that the lower standard of education should be abolished and Dr. Krishnan hoped in very near future India would have only medical colleges and no schools.

The number of medical institutions and the number of medical men produced from such institutions have a direct bearing on the needs of medical education of a country. Dealing with this question Dr. Krishnan pointed out that the standard aimed at in Western countries was to have at least one qualified doctor for every 1,000 of the population. India falls much below this standard and while she should have at least 400,000 doctors, ten times the present number, she is having only about 1,700 new doctors every year, produced jointly by the ten medical colleges and 27 medical schools in existence. Dr. Krishnan stresses that unless some practical plan is put forward to hasten production, it will take years before India can hope to solve this question of inadequacy.

Side by side there is the problem of rural needs, which, it must be admitted, are not being

satisfied at all at present. India is predominantly a rural country; 95 per cent. of her vast population live in rural areas. The majority of these receive little or no medical aid. Although many attempts have been made to provide in the past, medical aid to rural areas, with the help of men we have been producing in our colleges, no great success has been achieved so far. This is mainly due to the fact that right type of men do not come forward to serve and also appropriate training is lacking. Dr. Krishnan suggests that it is the duty of our medical colleges to select the right type of men and train them suitably.

The importance of women doctors is also emphasised. The total number of women doctors in this country is quite small and utterly inadequate. India, with her medical problems so closely intermingled with her social problem, has a greater need for women doctors than even Russia has (where there is the largest proportion of women doctors, almost 50 per cent.). The medical colleges should throw open their doors freely to women, and offer scholarships in sufficient numbers to attract the right type.

Making suggestions for the improvement of medical education in this country, Dr. Krishnan divides medical training into two parts—undergraduate and post-graduate. Advancement of science can only be achieved through men with a scientific bent of mind. It is the responsibility of the medical colleges to produce such men through inclusion of research programme in education. In India most medical colleges have only limited resources for prosecuting research. Dr. Krishnan suggests that in quantity and quality their research activity need to be much augmented. He also lays emphasis on the importance of providing adequate clinical facilities for teaching purposes. It should be made compulsory for the students and the staff to spend more time at the bedside than in the lecture room or laboratory as at present. Certain reforms should immediately be introduced relating to the instructional staff of the Indian medical colleges in the interest of medical education. Serious damage had been done through allowing private practice to the paid teaching staff of medical colleges. This system should at once be stopped and the constitution of a separate cadre for teaching staff be introduced immediately.

Dealing with the post-graduate courses of study Dr. Krishnan lays stress that there should be training of specialists in one or other differentiated fields of medicine and that there should be refresher courses to the general practitioner and others to keep them abreast of recent advances in their field. For the advanced type of post-graduate training, separate post-graduate institutions are generally established which will serve the purpose of teaching, advice and research. The staff should be composed of men of superior calibre whose main duties should be to give advice on all important scientific matters and to undertake research on problems of national importance.

After discussing the various aspects of medical training, Dr. Krishnan points out that almost all the colleges in India are of the ordinary type. The modern tendency is to have wherever possible medical colleges of the University type which, in the words of Abraham Flexner, "would address itself wholeheartedly and unreservedly to the advancement of knowledge, the study of the problems from whatever source they come and the training of men all at the highest level of possible effort". A few colleges in India are struggling towards the university type, and these can be reorganised and remodelled in the near future.

After discussing the various aspects of medical education and giving tentative suggestions for development or improvement in certain directions, Dr. Krishnan remarks that whatever may happen, one thing is certain that the future of medicine in this country will largely depend upon the attitude taken by the Government, the medical profession and the public on the indigenous and other systems of medicine, on the type of medical service and on the basic premical cause of ill-health. We must make up our mind as to what to do with the Ayurvedic and Unani systems of medicine. Dr. Krishnan thinks that these indigenous systems are antiquated and empirical and any sympathy or attachment to them will retard scientific progress. The type of medical service best suited to this country has also to be decided. We must study beforehand the situation in this country thoroughly and find out the type of medical service that will readily and truly take the benefits of modern scientific medicine within the reach of every individual in the country, urban and rural. And lastly, it has to be realised that the medical problem is closely connected with the social and economic problems. Unless we stamp out the basic causes of ill-health, namely, ignorance, poverty and lethargy, we will never attain any measure of success with any of the schemes. N. N. D.

PHYSIOLOGY

President: Dr. S. N. Mathur

HARMONY AND RHYTHM IN NATURE

SOME of the fundamental factors, such as, CO_2, temperature, oxygen and alternate periods of rest and activity, which are necessary for the harmonious working of the body are dealt with in this address.

The role of CO_2 in normal activities of the organs has been discussed. CO_2 is the natural excitant to vaso-motor centre. It actively increases dilatation of the heart, which indirectly results in an increased cardiac output. A certain tension of CO_2 is essential for the entire activity of the heart. CO_2 is necessary to maintain and regulate the activity of the rhythmic respiratory centre. Besides these, it plays an important part in the regulation of pH of the blood and other fluids and "indirectly ministers for the digestive needs of the body".

The regulation of internal temperature is of greater importance than the maintenance of CO_2 balance. It is found that at higher temperatures the respiratory centre is tuned to work at lower CO_2 tension and at lower temperatures, respiration and circulation become slow and CO_2 tension is raised, a mechanism directed for regulation of temperature rather than maintenance of CO_2 tension.

At low temperatures associated with anoxia, respirations become hurried and heart beats faster, showing thereby that a constant supply of adequate amount of oxygen is even a greater

need to the body than maintenance of temperature.

Of primary necessity to life is, however, alternate periods of rest and activity. Next to oxygen comes sleep. Sleep is presided over by the cholenergic part and wakefulness by adrenergic part of the autonomic nervous system. "On this conception the vagus nerve of the heart is considered not an inhibitor but as a nerve which controls and regulates the restful component of the rhythm of the heart and restores the energy lost during contraction."

Besides this diurnal rhythm of sleep and wakefulness, the body as a whole exhibits a less obvious yearly rhythm, consisting of increased activity during spring and summer, and lessened activity during autumn and winter, and thus pulsates with the rest of nature. The yearly rhythm of the body is apparently under the guidance of the two components of the autonomic nervous system. S. H.

ENGINEERING AND METALLURGY

President: MR. J. J. GHANDI

INDUSTRIAL RESEARCH

(With Special Reference to India)

THOUGH the realisation has come that organised research, pure and applied, is an absolute necessity in the present-day economic conditions of life, our research organisation in this country is still in the stage of infancy and the fields of industrial research yet to be covered are vast and boundless. How best this organisation can be improved, developed and expanded must be uppermost in many minds. A brief review of the development of Industrial Research Organisation in India starting with the constitution by the Government of India of the Board of Scientific Advice in 1902 to the establishment of the Board of Scientific and Industrial Research in April 1940, shows how slow, inadequate and unco-ordinated are the scientific and industrial research activities in this country. A study of the history of organised research in Germany, Great Britain, United States of America and U.S.S.R. serves to indicate in great contrast our vital weaknesses in the field.

It is often urged that war has filled many gaps in India's industrial structure. The statement is misleading. The gaps filled are relatively few and, by no means, of great importance: the major gaps are still unfilled. Even Australia and Canada have been able to accomplish much more in the industrial field than India and are now several paces ahead of us.

There can be no doubt to-day that if India is to survive in the post-war world of progress and competition, in which there will be more of international co-operation and less of national tariff protection, and efficiency will be the main criterion of success, we must draw up a blue-print of what our research organisation should be after the war, and do so now. There is no time to be lost.

To my mind, national research must be planned on national lines in order to prevent clashes of sectional interests, territorial and occupational, and obviate unnecessary overlapping of work and the consequent waste of money and effort. It must be adjusted to the economic structure of the country and not be a blind repetition of some foreign model. The Government, the University and Industry, each must be assigned distinct research functions, though all three must work in close collaboration towards the same end.

To summarise my proposals: The existing Board of Scientific and Industrial Research should be retained, but its membership should include a larger number of scientists than at present, so as to cover all branches of science, and the functions of the constituent bodies of the department should be slightly re-classified to prevent overlapping. The official scientific services should be autonomous in their daily operation, but should co-operate with the above-mentioned department of research. A supreme National Academy of Sciences representing the existing scientific societies should be brought into existence to co-ordinate the work of the various scientific societies and co-operate with the Board of Scientific and Industrial Research in general scientific direction. Provision has also been made for bringing industry into contact with science, and both, into contact with Government, and some indication given of the media of publicity that can be usefully exploited. M. A. G.

PSYCHOLOGY AND EDUCATIONAL SCIENCE

President: MR. JOHN SARGENT

THE practical aspect of Educational Reconstruction was the subject of the Presidential Address of Mr. John Sargent, C.I.E., to the Section of Psychology and Educational Science of the Thirty-first Indian Science Congress held in Delhi.

After stating that "anyone who knows anything about the present state of education, to say nothing of other social services in this country will realise that the question is anything but a rhetorical one", and pointing out that in such instruments as education we see the means of raising standards to a level which will at least make government of the people by the people for the people a practical proposition, Mr. Sargent says: "An India, 85 per cent. of whose population are illiterate and liable as we have seen more than once in recent years, to be stampeded by political and religious excitement, however irrational, constitutes a field for mischief-makers, the infinite continuance of which world opinion in search of a more stable future can hardly be expected to tolerate. Is it unreasonable to anticipate that whatever may satisfy government or big business or all the other vested interests, whose vision is either oblique or retrospective, the logic of any post-war settlement will demand a drastic change in the present state of things?"

Mr. Sargent then states the minimum programme of development and essential requirements, which will place India on an approximate educational level with other countries. The scheme provides for a national system of education to provide all children in India with eight years of basic education and enable promising children to pass on to high schools, universities, technical and commercial schools

and art institutions. The following are the essential requirements in brief:—

(1) Universal compulsory and free education for all boys and girls from the age of five or six until fourteen, in order to ensure literacy and the minimum preparation for citizenship.
(2) A reasonable provision of education before the compulsory age for school attendance in the form of nursery schools and classes. This is particularly important in the interest of health in areas in which housing conditions are unsatisfactory.
(3) Secondary or high school education for those children, who show the capacity for benefiting by it. Variety, both in types of school and in the curricula of individual schools, to suit the varying tastes and aptitudes of the individual pupils, is essential. In addition, so that no boy or girl of outstanding ability may be debarred by poverty from further education, liberal financial assistance in the form of free places, scholarships and stipends must be forthcoming.
(4) University education, including post-graduate and research facilities for picked students.
(5) Technical, commercial and art education.
(6) Adult education, both vocational and non-vocational, of all kinds and standards to meet the needs of those who were denied adequate opportunities in their earlier years.
(7) Arrangements for training the vast army of teachers, which a system of this kind will require.
(8) An efficient school medical service, which will see the children are made healthy and keep healthy.
(9) Special schools for children suffering from mental or physical handicaps.
(10) Recreational facilities of all kinds.
(11) Employment Bureaux, to guide school and college leavers into profitable employment.
(12) An administrative system which will place initiative and authority in the hands of those who understand and care about education.

These requirements, states Mr. Sargent, can hardly be described as extravagant. They were all covered by the British system of Education as it existed before the war, while in many parts of the United States of America and in some European countries a still more liberal system of public instruction was available.

Then Mr. Sargent examines how far the Indian system, as it exists to-day, falls short of these desiderata and whether it is practicable to build upon it a national system on the lines which have been already outlined. Speaking of compulsion, he says that it exists only in a very limited number of areas, usually towns, and covers only the primary stage, and in the majority of cases, compulsion is admittedly a failure. Further, an examination of figures of enrolment by classes shows that less than one out of every four children stayed long enough at school to reach the earliest stage, *viz.*, Class IV, at which permanent literacy is likely to be attained. The result is that the money spent on the others (nearly 80 per cent.) may be regarded as almost entirely wasted.

He then speaks of teaching service in India and states that the average pay of a primary teacher in Government schools in India is about Rs. 27 per mensem and in private schools is below Rs. 10 per mensem; and such a service can hardly attract the sort of people who ought to be in charge of the nation's most valuable asset, *viz.*, its children during its most malleable stage. In Great Britain the scales of salaries of ordinary assistant teachers in primary schools range from £150 to £408 per annum.

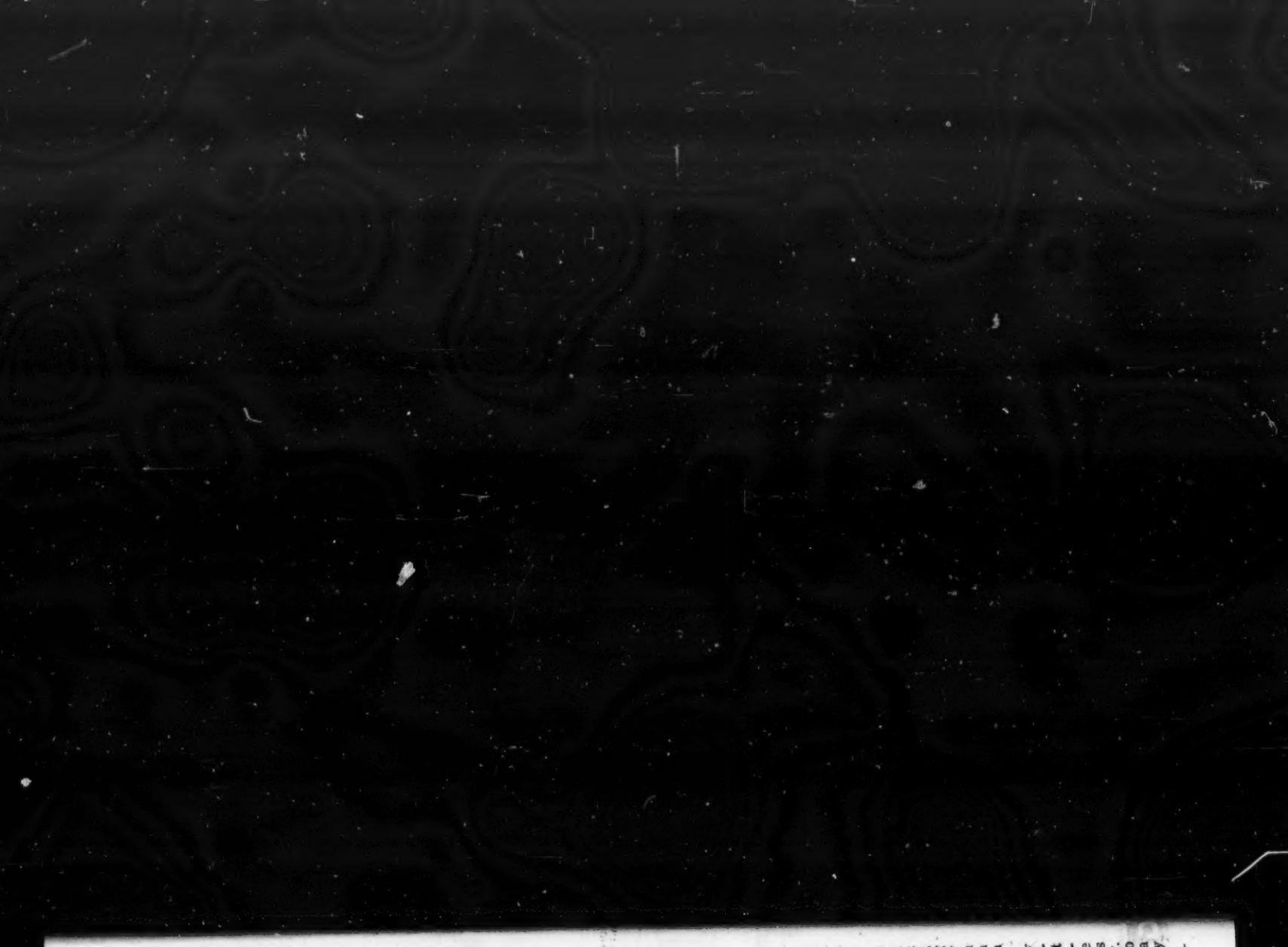
As regards adult education, Mr. Sargent says that at least 85 per cent. of the population of India is illiterate, and if the problem of illiteracy is to be dealt with as effectively and quickly as appears to have been the case in Russia, it will have to be attacked at both ends, *i.e.*, by the establishment of universal, compulsory and free primary education, and by the provision at the same time of abundant facilities for those whose education was neglected in their earlier years.

Mr. Sargent points out that if a national system of education is to be introduced within a reasonable period it will have to be not merely subsidised but also stimulated and co-ordinated from the Centre. This means a strong education department in the Central Government. He then concludes that the present Indian system of education when considered either on its merits or in comparison with systems in other countries, is deficient in almost every branch and that if any real progress is to be made a large part of what exists to-day will have to be scrapped.

Then the expenditure on education to bring it to the same level as existed in other countries before the war is considered in detail, and Mr. Sargent concludes that for British India the scheme would cost by the time it is fully established, *i.e.*, at the end of forty to fifty years, Rs. 313 crores annually, of which Rs. 277 crores will probably have to come out of public funds.

As regards the actual working of the scheme it is suggested that the work might be spread over eight five-year programmes, the first being devoted to working out plans in detail, regarding the administrative system and setting up the training schools and colleges necessary to provide the teachers required. During each of the succeeding seven periods an area roughly equivalent to one-seventh of the area of each province would be taken in hand.

Concluding, Mr. Sargent says, "If my premises are accepted, there can be no halfway house between what is and what ought to be. It is all or nothing. All means expenditure on a scale which frighten those who have defended inertia on the ground that India is too poor to have what other countries enjoy. Anything less than all means—and there is no evading this conclusion—that India accepts a position of permanent inferiority in the society of civilised nations."

B. V. S.

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